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ABSTRACT

This manual is intended to integrate the two disciplines of wildlife management and city planning. It seeks to provide a basis for communication between practitioners in the two disciplines as well as providing guidelines for wildlife management within the urban setting. Information on wildlife typically found in the urban area is provided along with discussion of their needs. Technical guidance on incorporation of wildlife considerations for the planning process is provided. The document also discusses the impact of environmental influences of the city on wildlife. (RE)

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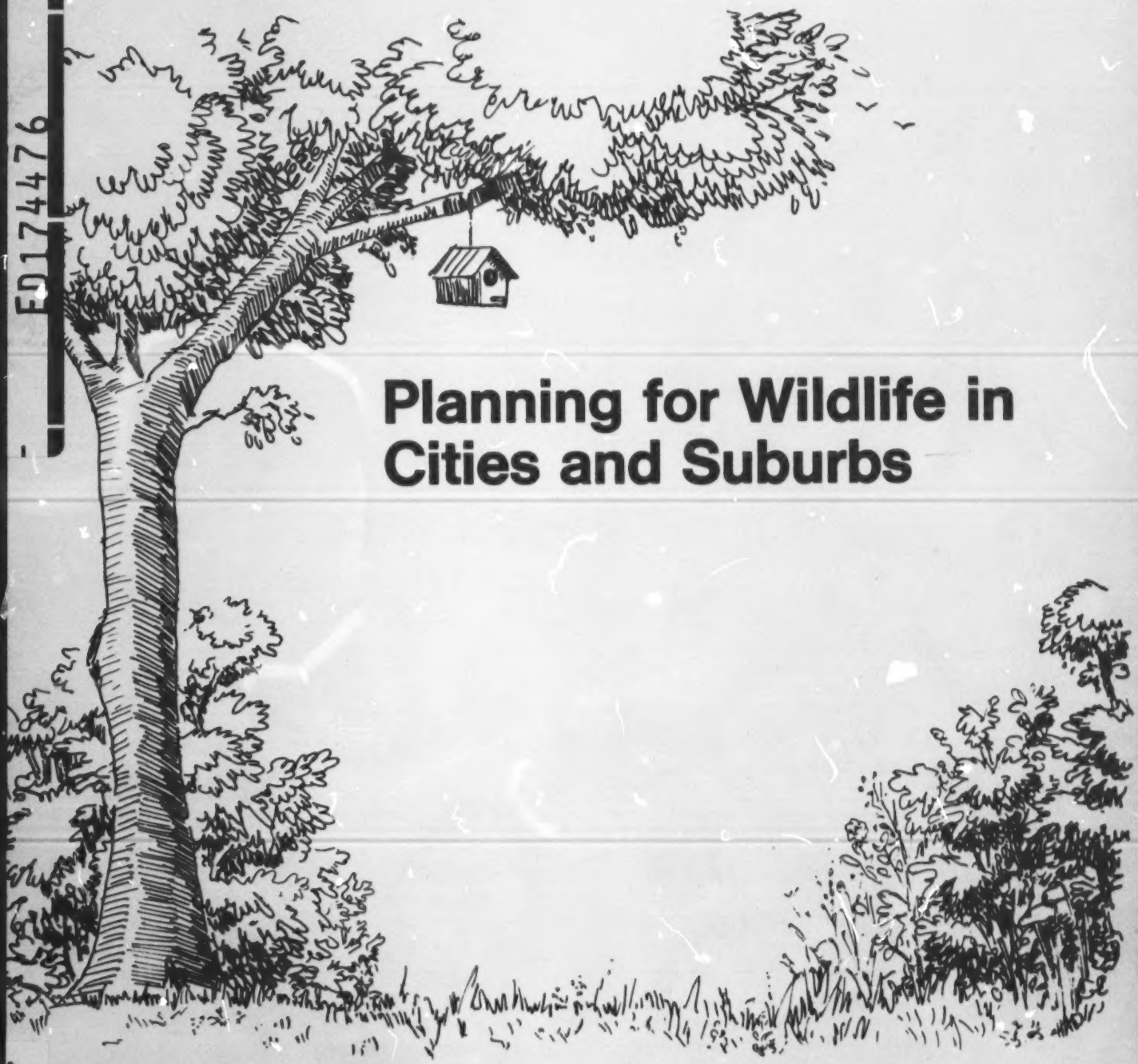

Planning for Wildlife in Cities and Suburbs

Fish and Wildlife Service

U.S. Department of the Interior

SE 028 548

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Planning for Wildlife in Cities and Suburbs

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Foreword

Planners have paid little attention to wildlife. Except for a short section in a city or regional environmental inventory or a few words in an environmental impact statement, wildlife issues are largely ignored. Wildlife is considered a luxurious concern, an afterthought at best in planning for open space or designing a development site plan.

But it need not be. Attracting wildlife can be a way to improve the quality of the environment in general. Applying the principles and guidelines set forth here to community and site planning, open space design and management, and architectural design can help add the amenity of wildlife to our urban and suburban environments. Little needs to change in the planning and design process, and usually little extra cost is involved.

This manual represents the meeting of two disciplines—wildlife management and planning—that have had little to do with each other. It reflects the authors' expertise and years of research in wildlife biology and management and their experience in applying this knowledge to the development process. While much of this material is familiar to wildlifers, it has never before been interpreted and presented this way.

If this publication does little more than open up lines of communication at the local level between planners and wildlife managers and biologists, it will have served its purpose. But we believe it will do much more. It will sensitize planners to principles and practices of wildlife management that will enhance our communities. Further, it will provide practical guidelines for incorporating a wildlife approach into planning procedures.

ASPO has encouraged the work of the Urban Wildlife Research Center since its founding about three years ago. We are particularly pleased to publish this work and to express our appreciation to the authors and to the U.S. Fish and Wildlife Service for its support.

Michael J. Meshenberg
American Society of Planning Officials

Preface

Wildlife planning and management in urban and suburban areas has been largely neglected. Traditionally, most wildlife research, with the exception of some investigation on animal control, has been directed toward game species in rural or wild areas rather than toward urban wildlife. Recently, however, more consideration has been given to problems of environmental quality in urban and urbanizing areas, and more appreciation of wildlife has been evident. Some developers now realize that wildlife can provide not only an aesthetic amenity, but financial benefits as well. Planners also are recognizing the importance of incorporating wildlife into urban design, but they find few guidelines to help them. Their attempts to use the expertise of wildlife biologists often have been hampered by a lack of common ground between the two professions. Biologists have not understood the planning process; planners often have wanted more practical and implementable advice and assistance than the wildlife biologists were able to give.

The authors hope to achieve two basic goals: (1) to develop an appreciation of wildlife considerations as an integral part of planning activities and (2) to provide guidance for incorporating the principles of wildlife management into the planning process.

In this manual, an effort has been made to present a methodology that can be utilized by planners with little or no background in wildlife ecology. The need for input from biologists is recognized, however; and suggestions are made as to how planners, developers, and biologists can work together. The planning approach defined in this manual has been kept general so it can be used widely.

Chapters 1 and 2 provide information on wildlife found in urban and suburban areas, urban wildlife values, effects of urbanization on the environment and the response of fish and wildlife to habitat changes, and the need for wildlife planning and management. Chapter 3 deals with the basic needs of wildlife, the nature of wildlife management and its relationship to urban planning, and the need for planners and biologists to work together in developing urban environments more favorable to both people and wildlife. Chapters 4, 5, and 6 provide guidance for incorporating wildlife into site and regional planning as well as into existing urban areas. Emphasis is placed on planning activities in undeveloped areas, since this is where the greatest results can be achieved. Chapter 7 provides more details on the wildlife management implications and opportunities associated with some components and planning activities common to both urban and urbanizing communities. Items treated include water and water management, sediment and erosion control, open space and vegetation management, streets and highways, and airports. Chapter 8 outlines principles and suggested approaches to wildlife planning and management. It both provides the reader with an easy reference to appropriate sections of the manual and serves as a listing of the principles involved in planning for wildlife amenities.

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Stephen R. Seater, former administrative director, Urban Wildlife Research Center, served, initially, as a liaison officer between these two organizations and collected much material pertinent to the development of the manual.

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Chapter 1. Introduction

Birds, mammals, fish, reptiles and amphibians, butterflies and moths, and many other creatures share Planet Earth with us. As a species with the ability to think, plan, and alter the environment in ways no other species can, man has responsibility for managing and protecting the environment and fish and wildlife resources in the public interest, now and for generations to come.

Without plants, animals—including man—could not survive; and, although man may depend primarily upon cultivated plants for his food, many wild creatures depend upon noncultivated plants for food and shelter. What would this world be like without the thousands of other animal species we have learned to know and enjoy as part of our environment?

Thus, fish and wildlife in this context are viewed broadly as the nondomesticated animals, primarily vertebrates, that are present in the urban or suburban setting or in nearby areas. We shall discuss the environmental conditions necessary for their existence as well as the effects of mankind upon them.

Although the fields of planning and wildlife ecology are not new, only recently have efforts been made to link the two. These efforts have achieved some degree of success but have been hampered by the lack of applied research in urban wildlife planning.

Many critical questions still remain to be answered: How much open space is required? What is the effect of human disturbance on wildlife? What configuration of open space is most beneficial? How wide must connecting corridors between open space parcels be to encourage movement through them by wildlife? What specific requirements have to be met to retain preferred species?

With the increasing interest in urban wildlife research, we hope these and other key questions can be answered in the near future. Meanwhile, we do have information to draw upon, based on past experience in the planning field and on research generated mainly from studies of wildlife in natural situations, but including a few studies of wildlife in urban and suburban areas.

Thus, although the state of the art is not very far advanced, the guidance provided in this manual should help planners to increase significantly the wildlife amenities in development projects. Planners and wildlife biologists, by attempting to integrate the approaches suggested here, can provide significant input to refinement of the urban wildlife planning process.

Although Aldo Leopold, the founding father of wildlife management, was speaking of birds in the following statement, his words apply to wildlife in general:

> Environments can, by the judicious use of those tools employed in gardening or landscaping or farming, be built to order with assurance of attracting the desired bird. In short, by deliberately and intelligently revising the processes which are destroying bird environments, we can restore not only birds in general, but those particular birds in which the landowner may have a special interest.
>
> This is the substance of game management, and can likewise become the means whereby each community creates its own dearth or abundance of nongame birds. Is it not probable that landowners who now proudly exhibit their bird baths or feeding stations will be equally enthusiastic about the diversity of bird environments which they can build up? Should not public parks be "landscaped" with an eye to the variety of their bird life, as well as to the beauty of their scenery?[1]

In this manual, we hope to provide some insight as to the requirements and means of creating and maintaining a better environment for both wildlife and people in urban and suburban areas. If this goal is to be achieved, there are opportunities for, as well as work to be done by, regional planners; site planners and developers; federal, state, and local governments; and private landowners and urban residents.

WILDLIFE IN CITIES AND SUBURBS

Many different species of wildlife exist in urban and suburban areas—more than most people realize. Some are present because they have adapted to the urban environment, others because large areas of open space have been retained, either intentionally or unintentionally.

Some species, such as the pigeon, house sparrow, squirrel, garter snake, toad, and opossum, are common in ur-

1. Aldo Leopold, *Game Management* (New York: Charles Scribner's Sons, 1933; reprinted 1936), 481 pp.

banized communities. Some species occur in urbanized areas because of strange coincidences of time and place. Others are present because planning efforts have been compatible with wildlife needs, not necessarily purposely, but "accidentally," because of the type of environment provided.

City parks, in addition to providing habitat for many different resident species, also act as oases for small birds during migration. Many visitors, such as woodcocks, sapsuckers, thrushes, warblers, sparrows, and kinglets, can be observed at these times. Central Park in New York City functions as such an area to the delight of many bird watchers.

Many other interesting examples of the occurrence of birds in cities could be cited. For example, although the peregrine falcon is now essentially gone from the eastern United States, in past winters they have used the Willard Hotel and the Old Post Office in downtown Washington, D.C., as lookouts. And in Washington, D.C., several successive generations of barn owls have lived in a tower of the Smithsonian Institution.[2]

Any urban/suburban complex contains numerous sites that are frequented by birds of different types. A concentration of gulls is likely to be found at dumps or where sewers empty into a bay or river. Shore birds may be found along the edges of reservoirs, along the shores of coastal cities, and on river or tidal flats. Waterfowl frequent many urban water supply areas or recreation lakes.

The species tend to vary according to the geographic area, quantity and diversity of vegetation, and types of housing developments. Some urban communities, particularly if they include reservoirs or other water bodies, may have more diversity of habitat than the areas they replaced. Often these urban areas contain more birds—if not more species—than rural agricultural and wooded areas.

Urban waterfowl, although not without potential problems, can provide enjoyment to many people. More than 10 thousand mallards and two thousand black ducks spend each winter in Massachusetts parks and urban areas.[3] In the seven-county Twin Cities, Minnesota, area, some 1,800 giant Canada geese in 12 major flocks now share their environment with more than two million people.[4]

Many of the ducks in the duck pond at the Philadelphia Zoo have flown in by choice, because of the favorable conditions provided. Within the city of Philadelphia, the Schuylkill River is host to hundreds of Canada geese plus a wide variety of ducks, particularly during spring and fall migrations. Ten years ago a few Canada geese became year-round residents. In the spring of 1977, about 125 of these birds were nesting on Peter's Island in the middle of the Schuylkill River, within view of downtown Philadelphia. The island since has been declared a wildlife refuge center. Four-lane highways closely bordering both sides of the river have little effect on their presence, nor do the geese seem to be bothered by the many people picnicking, bicycling, or jogging on the grassy areas between the river and highways.

Although generally not as conspicuous as birds, many mammals also are found in urban and suburban areas. The seemingly ubiquitous Norway rat and the house mouse may be present in large numbers in grain elevators, warehouses, and other places where sufficient food, shelter, and water are available.

Probably squirrels are the most common wild mammals in cities. Tree squirrels are found in the forested portions of urban communities in much of the United States. Gray squirrels may become unusually abundant in urban situations, especially in the southeastern states, where they may reach densities of five to six animals per acre, exceeding the numbers in the wild.

In the northern states, especially where conifers predominate, red squirrels may live in urban areas. Fox squirrels are found in cities and towns of the Midwest, West, and South. Flying squirrels also may be present in urban woodlands but usually are not seen by city dwellers.

The gray squirrel is a good example of a game animal that has adapted to city life. High urban squirrel popula-

2. Irston R. Barnes, "Amid Brick and Asphalt," pp. 414-424 in *Birds in Our Lives*, Alfred Stefferud and Arnold L. Nelson, eds., Fish and Wildlife Service, U.S. Department of the Interior, 1966, 561 pp. (U.S. Government Printing Office, Washington, DC 20402.)

3. H. W. Heusmann and Richard G. Burrell, "Park Mallards," pp. 77-86 in *Wildlife in an Urbanizing Environment: A Symposium*, 1974. (University of Massachusetts, Amherst, MA 01002.)

4. Rodney D. Sayler and James H. Cooper, *Status and Productivity of Canada Geese Breeding in the Twin Cities of Minnesota*. Paper presented at the Thirty-sixth Midwest Fish and Wildlife Conference, Indianapolis, 1975 (Lincoln, Neb.: Association of Midwest Fish and Wildlife Commissioners, 1975), 12 pp.

tions have been attributed, at least in part, to the existence of large, mature, uncrowded, and productive mast trees with large canopies. These provide excellent squirrel food and shelter.[5]

Raccoons occur widely in the United States and often are found in residential neighborhoods, especially in wooded suburbs. Although they den in hollow trees, the lack of which may tend to be a limiting factor in some areas, they are known to den in burrows dug by woodchucks, red foxes, badgers, and skunks; and they find shelter in rock dens. They have demonstrated their adaptability through the use of garages, houses, drainage tiles, refuse dumps, and drain culverts for den sites.[6] Usually, raccoons are found within a few hundred feet of open water.

Numerous other wild mammals may occur in urban and suburban areas. Among these are deer, rabbits, skunks, chipmunks, mice, moles, shrews, bats, and even the adaptable coyote. Their habitats and behavior are diverse, as are their roles in nature and the out-of-doors. Certainly, life for many of us would be less interesting without them.

Although not as visible as other wildlife species, reptiles and amphibians also occur within urban areas. Urbanization, with its drainage of wetlands, degradation of streams, and removal of ground cover and brush, has generally decreased the populations of amphibians and reptiles. For some species, however, it may actually have permitted an increase, at least on a local basis, through the creation of man-made breeding sites (ponds, water-filled sand-mining pits, abandoned reservoir sites, and suburban water-recharge basins or sumps) and through the elimination of natural predators.[7]

5. Vagn Flyger, "Tree Squirrels in Urbanizing Environments," pp. 121-124 in *Wildlife in an Urbanizing Environment*.

6. J. R. Schinner, "Ecology and Life History of the Raccoon (*Procyon lotor*) Within the Clifton Suburb of Cincinnati," M. Sc. Thesis (Cincinnati: University of Cincinnati, 1969), 60 pp.;

D. L. Cauley, "The Effects of Urbanization on Raccoon (*Procyon lotor*) Populations," M.Sc. Thesis (Cincinnati: University of Cincinnati, 1970), 55 pp.

7. Frederick C. Schlauch, "City Snakes, Suburban Salamanders," *Natural History*, Vol. 81 (1976), pp. 46-53.

During urbanization, the damming of streams for recreational use, to create reservoirs, and for other purposes has probably created more deep-water ponds than naturally existed on Long Island. These ponds have provided suitable habitats for the common snapping turtle and the eastern painted turtle, both of which inhabit nearly all of the permanent ponds of Nassau and Suffolk counties and thrive, despite the pursuits of turtle collectors.

Urbanization also brings the earthworms, rats, mice, and trash that provide increased food and cover for some species of snakes. Urban lighting attracts insects that serve as food for toads.

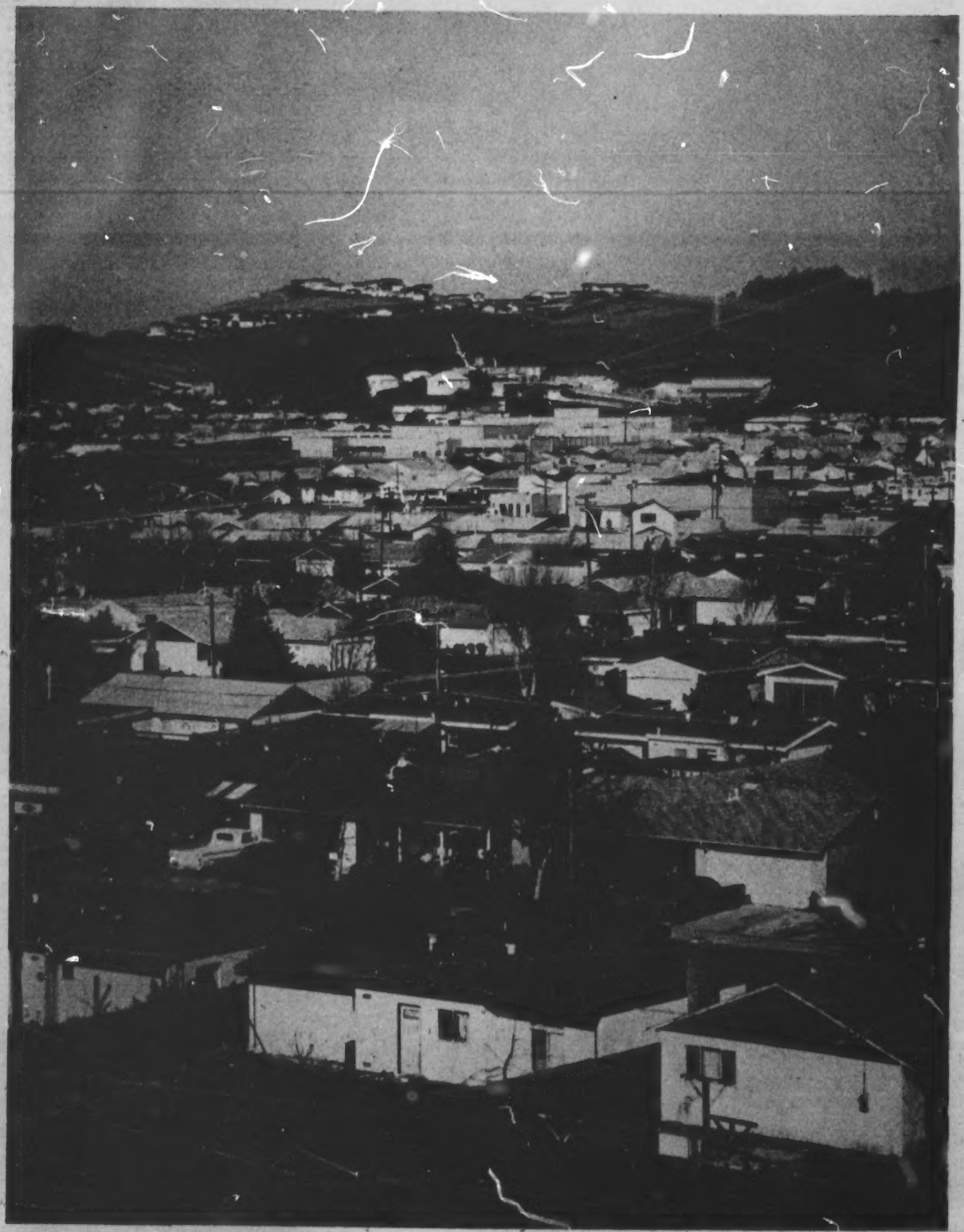
Some reservoirs, ponds, and other water developments in urban areas have been used for fish production. Several states have contributed to "community lake" programs that afford fishing opportunities. In addition, some individuals in suburban areas have developed productive fish ponds.

WHAT CAN THE PLANNER DO?

The examples cited above, particularly those in which wildlife exists in close association with human activities, indicate that a wide diversity of wildlife can be accommodated in urban and suburban areas if the proper conditions are provided. Although communities with these wildlife amenities have rarely resulted from planning efforts directed toward wildlife, their mere existence demonstrates the potential viability of wildlife planning efforts.

The planner can have a significant effect on the wildlife populations of existing and proposed communities. With the latter, particularly, the planner has more influence on the wildlife composition than most individuals and does not have to know much about wildlife to do it.

Although it is preferable for the planner to seek the assistance of trained wildlife biologists, significant benefits for wildlife can be achieved solely with the guidance provided in this manual. Most planners are sensitive to environmental opportunities and constraints. The guidance presented here will help planners to become as sensitive to wildlife as to other, better defined environmental concerns.



Development has taken over the valley and is moving onto the hills. The only open space left in the valley is the school playground (upper left).

Chapter 2. Why Wildlife Planning?

People involved in land planning and development activities often ask, Why should I care about incorporating wildlife in my planning and design work? Many arguments can be given in support of wildlife planning, based on ecological, aesthetic, educational, and financial considerations.

From an ecological standpoint, the existence of a wide variety of wildlife species in residential developments is indicative of the ecological stability of the area. The ecological principle that ecosystem stability is proportional to its diversity holds true for cities as well as for regions. Though it may not be apparent to the untrained eye, many species are required to make up the food webs and to help ensure the balance of nature.

It can be demonstrated that, because of the additional amenities, people prefer to live in communities in which wildlife has been integrated. Recreational benefits provided by wildlife in residential areas are many. More and more, people are deriving enjoyment from observing song birds at their feeders, and bird-watching has become a favorite recreational activity of millions. Additional recreational activities are afforded by the many ponds and lakes that are managed for fish and wildlife.

Wildlife within and adjacent to urbanized areas allows for educational and scientific pursuits and provides for the enhancement of educational programs. A development well endowed with wildlife also provides additional economic returns to the developer through increased property values. In addition, open space management programs directed toward wildlife frequently reduce management costs, as described in Chapter 7.

Planners have opportunities for integrating wildlife considerations into the design process through innovative approaches. Wildlife planning is becoming an exciting new field that can result in great personal satisfaction. It challenges the planner to develop and implement new ideas and techniques. While it is relatively easy to plan a community containing only a few desirable wildlife species, a planning design that will accommodate the required number of housing units and at the same time significantly increase wildlife amenities requires much more expertise.

The rapid increase in developed land, particularly in large metropolitan areas, continually decreases the exposure of people to wildlife. In many areas, residents have to go to a zoo or travel long distances to observe wildlife.

This situation could become increasingly pronounced in the future. While urban areas still occupy a relatively small percentage of the land area in the nation, the percentage of land in such use is growing. The population of the United States totaled almost 204 million in 1970 and is expected to be 222.5 million by 1980. Over the next 30 years, an additional 19.7 million acres of undeveloped land will be consumed by urban sprawl—an area equivalent to the states of New Hampshire, Vermont, Massachusetts, and Rhode Island. Each decade's new growth will absorb an area greater than the entire state of New Jersey; and each year the equivalent of 2.5 times the Oakland-San Francisco metropolitan region must be built to meet the nation's housing goals.[8]

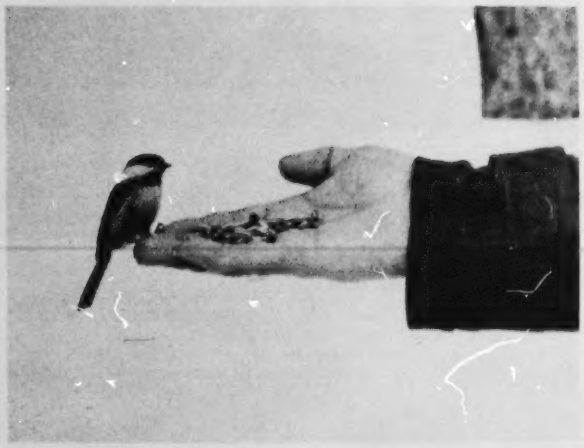
This growth would seem to emphasize the need for improving conditions in existing urban areas and for incorporating better planning and environmental management measures in new housing developments. The development and maintenance of a high quality environment in urban and suburban areas will not only enhance wildlife in such areas but permit people to understand and appreciate nature better. It is becoming more and more evident that regional and site planners will have an increasingly important role in the preservation of our wildlife heritage.

ATTITUDES TOWARD WILDLIFE

People's attitudes toward fish and wildlife differ. Some people value these resources highly. Others are fearful of having wildlife in their vicinity because of the possibility of snake bites, the nuisance of mosquitoes and flies, or the remote chance of rabies, sleeping sickness, or Rocky Mountain spotted fever.

Even those who enjoy watching wildlife at their bird feeders or in their yards may resent damage caused by wildlife to their gardens or their property. Millions of people—a majority of them from urban and suburban areas—participate annually in hunting and fishing. Additional millions engage in hiking, nature photography, and other

8. Sen. Henry Jackson (D-Wash.), in testimony March 6, 1975, on Senate Bill 984, authorizing the Secretary of the Interior to make grants to assist the states in developing and implementing state land-use resource programs (Washington, D.C.: *Congressional Record* 121: 36, 1975), 4 pp.



pursuits dependent upon wildlife and the natural environment.

Among the positive values of fish and wildlife in urban and suburban areas are those relating to people's enjoyment in day-to-day living and nature observations and environmental education. However, certain wildlife species—individual animals or concentrations of birds, for example—can become nuisances; create unsanitary conditions or cause deterioration of water quality; damage crops or property; and be a potential hazard to human health and safety.

Most surveys of suburban and urban residents have indicated that homeowners and others appreciate having wildlife on their properties or in the areas where they live, play, or work. For example, it has been estimated that total direct expenditures for the enjoyment of nongame birds in 1974 was $500 million—95 per cent of which was for birdseed, binoculars, and camera equipment.

Sales of birdseed alone amounted to $170 million that year. Bird-watching accounted for between one-half and two-thirds of the dollar sales of binoculars. Sales of gift books about birds totaled slightly over $4 million in 1974.[9] Twenty per cent of U.S. households buy 60 pounds of birdseed a year, regardless of price.

In surveys of homeowners in Waterloo, Ontario, Canada, almost everyone said they liked birds—particularly cardinals and robins—and most also liked squirrels, chipmunks, and cottontail rabbits in the city. Fewer than half liked having other animals on their property, usually because of damage to plants or property. Pigeons and starlings were less popular than other birds because their droppings defaced buildings; they carried mites that sometimes caused problems in houses; or they were noisy, messy, and too numerous. However, despite their acceptance of many wildlife species in the city, a large number of people were unable to identify many of the animals that were sometimes present.[10]

9. Brian R. Payne and Richard M. DeGraaf, "Economic Values and Recreational Trends Associated with Human Enjoyment of Nongame Birds," pp. 6-10 in *Proceedings of the Symposium on Management of Forest and Range Habitats for Nongame Birds*, General Technical Report WO-1, 1975, 343 pp. (U.S. Forest Service, Washington, DC 20250.)

10. Anne Innis Dagg, "Reactions of People to Urban Wildlife," pp. 163-165 in *Wildlife in an Urbanizing Environment.*

Residents in different parts of a city may perceive wildlife differently. In Tucson, people living on the edge of the city were aware of more species of wildlife than those living toward the center of town. People most aware of wildlife near their homes also were most aware of other conservation or environmental issues.[11]

In a survey of residents in five areas of metropolitan Detroit, none of the residents said they disliked the birds they saw in their yards. Generally, people in the inner city watched birds less than those in the suburbs and did not try to attract birds as much as suburbanites.[12]

A study undertaken in Taylor, Michigan, showed that the majority of people interviewed enjoyed seeing wildlife on their property and placed food out for wildlife some time during the year. About half the people favored a program emphasizing management of wildlife within the city if it could be done without cost to the taxpayer, but fewer than half favored such a program if there were cost attached to it.[13]

In Morgantown, West Virginia, a majority of the residents surveyed indicated they would be interested in planting certain trees or shrubs in their yards to attract wildlife.

The coyote, despite hunting, trapping, and other efforts at control, is still to be found in Southern California, an area now inhabited by 13 million people. Some of the people in the Los Angeles area are clamoring for more protection of the coyote, while others, who may be disturbed by howls at night and who fear for the safety of their dogs, cats, and guinea pigs, would like to have more coyote control.[14]

In recognition of the need for more attention to environmental affairs, including urban wildlife, the people of Missouri voted for a self-imposed tax that will provide millions of dollars annually for relevant programs.

Perhaps one of the most important benefits associated with urban wildlife and its supporting habitat is the potential influence on children. There is evidence indicating that interaction with the natural environment enhances physical development and intellectual and social competence.

The maintenance of diverse natural communities in the city thus may be regarded as an exercise in preventive medicine. It is also a means of generating in citizens an understanding and respect for the land on which our livelihood depends.[15]

11. Thomas Richard Szot, "Perception of Urban Wildlife by Selected Tucson Residents," M.A. Thesis (Tucson: University of Arizona, 1975), 121 pp.

12. James R. Schinner, "An Analysis of the Interrelationship of Habitat and Avifauna in Metropolitan Detroit," Ph.D. Thesis (East Lansing: Michigan State University, 1974), 201 pp.

13. Darrel L. Cauley, "Urban Habitat Requirements of Four Wildlife Species," pp. 143-147 in *Wildlife in an Urbanizing Environment.*

14. Howard R. Leach and Eldridge G. Hunt, "Coyotes and People," pp. 117-119 in *Wildlife in an Urbanizing Environment.*

15. Valerius Geist, "Wildlife and People in an Urban Environment—The Biology of Cohabitation," pp. 36-47 in *Wildlife in Urban Canada: A Symposium* (Calgary: University of Calgary, 1975).

WILDLIFE AND REAL ESTATE VALUES

Most residents prefer a community well endowed with wildlife amenities. If this is not sufficient incentive for integrating wildlife into the planning process, planners and developers also should be aware that wildlife amenities result in increased property values as well. Little documentation is needed to support the fact that higher prices can be charged for new housing developments that are well integrated into a liberal open space system. The increased values are related directly to the open space and natural setting provided and indirectly to the wildlife amenities afforded from this open space. It become difficult to determine the proportional value attributable to each.

Wildlife values are indeed difficult to measure and often are of an intangible nature. The urban dweller fortunate enough to hear the song of a wood thrush in his backyard or perhaps to see a scarlet tanager against the green foliage of an oak would agree that wildlife adds to the aesthetic and environmental quality of his neighborhood.

In his classic book, *Game Management*, Aldo Leopold states, "A pair of wood thrushes is more valuable to a village than a Saturday evening band concert, and costs less. What does it cost? A piece of woodland with undergrowth." This may be debatable, but the point is well taken, nonetheless.

The U.S. Forest Service has suggested that the presence of trees around a house has a tangible effect on its marketability. Research conducted on this subject indicates that trees enhance the value of a property by as much as 20 per cent and increase the value of architecturally similar houses by an average of five to 10 per cent.[16] Trees offer beauty and shade and, in addition, provide habitat for wildlife.

Wildlife considerations were an integral component of the planning process of the Woodlands, a new town north of Houston, Texas. Efforts were even made to return deer, among many other species, to the site. Discussions with the developers indicate that the presence of wildlife added significantly to the value and salability of the residential properties.

EFFECTS OF URBANIZATION ON WILDLIFE

Urbanization, like agriculture, forestry, and the development of transportation, affects the environment and fish and wildlife as well. Historically, the process of urbanization has been carried out with little consideration for fish and wildlife. As a result of the march of civilization, populations of some species of wildlife—all too often, the so-called nuisance species—have increased, while other species have declined or, in some cases, have been eliminated completely.

The effects of urbanization on fish and wildlife make incorporating fish and wildlife into the planning process all the more important if desirable populations of species are to be maintained for the benefit of people, the majority of whom live in urban areas.

During the settlement and expansion of this country, people were more dependent upon fish and wildlife for food and clothing than they are today. Despite the shooting and trapping of wildlife species for food, clothing, and profit, the alteration of the habitat had the greatest impact on wildlife.

Thus, with the clearing of the forests, many forest-dwelling species declined, and species better adapted to agriculture and open areas increased. With the draining of marshes and other wetlands, waterfowl, shorebirds, and other aquatic wildlife species declined, while some types of wildlife better adapted to agricultural habitats increased.

On the other hand, construction of reservoirs and farm ponds and irrigation of dry lands created new habitats for certain fish and wildlife species. Farming, timber harvesting, overgrazing by livestock, and construction of roads accelerated erosion and degraded streams and lakes.

With increased population growth and industrialization, problems of waste disposal and pollution increased, and further deterioration of fish and wildlife habitat resulted. Many of the pesticides used to combat insects injurious to crops also destroyed or adversely affected desirable forms of fish and wildlife.

Urban populations of humans are dependent upon much larger areas for food and materials. Supplying their needs has required increased agricultural production; increased extraction of fuel, sand, and gravel; and countless other activities that have affected wildlife populations.

In most conventional residential development, the land is stripped of much of its vegetation and divided into rectangular plots. In the process, many of the smaller natural drainage channels are obliterated and must be replaced by enclosed storm sewers.

For example, a 26-square-mile section of the Rock Creek watershed in Maryland had 64 miles of natural flowing streams in 1913 when the area was rural. In 1966, the same area, now a heavily populated suburb of Washington, D.C., had only 27 miles of flowing streams.[17] An in-

16. *Trees Could Make a Difference in the Selling Price of Your Home*, undated, 4 pp. (Northeastern Forest Experiment Station, U.S. Forest Service, 6816 Market St., Upper Darby, PA 19082.)

17. Theodore W. Sudia: *Man, Nature, City: The Urban Ecosystem*, Urban Ecology Series, No. 1, U.S. National Park Service, 1974, 22 pp. (U.S. Government Printing Office, Washington, DC 20402.)

The builders of Columbia, Maryland, were careful to preserve trees and topography. The extra effort added to property values, reduced erosion, and preserved habitat for wildlife.

creased rate of runoff and a lowering of the water table occur as a consequence of development. Animals dependent upon springs, small streams, and tributaries suffer a loss of habitat.

In addition to increasing the rate of runoff and impeding the infiltration of water to recharge aquifers, the pavement and buildings that now cover much of urban America, especially the inner core, leave little space available for the growing of shrubs, trees, and other vegetation under anything but artificial conditions requiring great expenditures of time and money.

In this regard, ecologist Forest Stearns has said:

> American cities are physically complex systems in which the animal biomass exists by chance or for aesthetic considerations. As they become increasingly devoid of species and habitat diversity, cities tend toward an encompassing monotony which, in other systems, ecologists recognize as leading to imbalance and disruption. The implications of ecological concepts such as diversity, succession, energy and nutrient flow, population dynamics, and territoriality are pertinent to the management of older cities and the development of new ones.[18]

In the process of construction and development, erosion may increase as much as two thousand times over the amount of erosion occurring in wooded areas. Topsoil often is not saved for later use, and gravel and silt are carried downstream, with devastating effects on fish and other aquatic organisms.

The increased use of pesticides in urban areas poses serious problems for wildlife. The use of pesticides has resulted in the loss of amphibians, reptiles, fish, birds, and mammals.

It has been estimated that the amount of pesticide used within urban areas may equal the amount used in agriculture—some 500 million pounds of material.[19] The pesticides and fertilizers used in abundance by urban residents contribute to pollution and to the enrichment or eutrophication of urban streams and other water bodies.

The use of pesticides in suburban homes and gardens has caused reduction of growth rate generally in fish and other aquatic animals as a result of altered food conversion and altered reproductive potential, both in terms of number of eggs produced and survival of young. Also, there appears to be a general reduction in fitness of all aquatic organisms and increased susceptibility to disease, capture, or the effect of parasitic infection as a result of long-term, low-level exposure.[20]

Damage could be reduced by using those pesticides shown to be least harmful to fish and wildlife. It is important to follow the directions on the pesticide containers exactly for dosage rates and application methods. Care should be exercised in cleaning equipment and disposing of containers and unused materials. It is essential that they not be discarded in streams or lakes because they can be poisonous to aquatic life.

Maintenance of a variety of native trees and shrubs in urban areas and use of biological control methods may reduce the need for the application of so much chemical pesticide and fertilizer. In Berkeley, California, a successful pest management program using biological control methods was developed between 1970 and 1975 for the city's 30,000 street trees.[21]

Some more specific examples of the effects of urbanization on wildlife may be useful. The effect of the develop-

18. Forest Stearns, from a statement made at an AAAS symposium sponsored by the Wildlife Society and the Ecological Society of America in Chicago, December 30, 1970. See also M. Kirkpatrick, *The Wildlife Society News*, No. 133 (1976), pp. 13–14.

19. W. Olkowski et al., "Ecosystem Management: A Framework for Urban Pest Control," *BioScience*, Vol. 26 (1976), pp. 384–389. (American Institute of Biological Sciences, 1401 Wilson Blvd., Arlington, VA 22209.)

20. R. V. Rumber et al., *The Use of Pesticides in Suburban Homes and Gardens and Their Impact on the Aquatic Environment*, Pesticide Study Series-2, 1972, 61 pp., appendices. (Applied Technology Division, Office of Water Programs, U.S. Environmental Protection Agency, Washington, DC 20460.)

21. Olkowski et al, "Ecosystem Management."

ment of the new town of Columbia, Maryland, on bird populations has been documented.[22] As the sparsely populated farmland area of 13,400 acres changed in eight years to a community of 27,000 people, typical farmland species declined. Among these were the bobwhite quail and mourning dove; field-inhabiting birds like the eastern meadowlark, red-winged blackbird, and grasshopper sparrow; and wood and woodland-edge species, such as the wood thrush and indigo bunting.

On the other hand, a dramatic increase was seen in mockingbirds, chipping sparrows, and song sparrows. The increase in mockingbirds was believed to be associated with the large number of fruit-bearing shrubs planted for ornamental purposes.

The most striking increases were in starling and house sparrow populations. These birds were virtually absent from the area before development but were the most common species following development. Populations of these two species were closely associated with the construction of buildings that afforded holes and ledges for nesting and roosting.

Areas in which detached homes were built and where some of the original trees and ground cover were retained had the most varied bird species composition among the developed areas.

In urban areas with previously existing or newly created bodies of water, populations of waterfowl and other water birds are likely. Construction of lagoon or finger-type housing developments in coastal areas that require dredging and fills, however, has destroyed much salt marsh habitat of great value to fish and wildlife. Such developments in New Jersey resulted in the almost complete loss in a 14.2-square-mile salt marsh habitat of all species except the mallard, which has been able to adapt to the changed conditions.[23]

As noted earlier, squirrels, raccoons, rabbits, opossums, and many other mammals are to be found often in urban areas when adequate vegetation is retained.

Although not so obvious, urban areas often contain populations of amphibians and reptiles, particularly when streams and wetland areas have been maintained. The importance of amphibians and reptiles in urban areas should not be underestimated because, in addition to their aesthetic and educational values, some species are very valuable in food chain systems and provide some natural pest control.

As in the case of birds, some species of amphibians and reptiles have benefited from the alteration of habitat, but for most species, the changes have been detrimental. Clearing the land and removing ground cover and under brush affect all terrestrial species, but it is particularly hard on salamanders and some snakes.

Modification of aquatic habitats by drainage, dredging, pollution, and removal of vegetation has serious effects on all amphibians except those whose egg and larvae stages are spent on land or in small or transient collections of water. Road construction and subsequent traffic can be devastating when it denies a population free access to its hibernating or breeding areas. The killing of the larger snakes by man and the killing or collecting of turtles can be factors in destroying populations of these reptiles, especially when the populations have already been endangered by alteration of habitat.[24]

It has been suggested that urbanization even affects marine species. Bright city and highway lights in coastal areas where certain sea turtles lay their eggs on shore are thought to confuse the hatching turtles and attract them inland, where they die. Apparently at least three species of these sea turtles—the green, the loggerhead, and the Pacific ridley—have been pushed closer to extinction by increased development of coastal shorelines.[25]

What has been said about the effects of urbanization with respect to amphibians and reptiles also applies in large part to fish. The filling and drainage of wetland areas, ponds, and bays and the channelization and converting into storm drains of many small streams and tributaries have destroyed much habitat for fishes and other aquatic organisms.

Likewise, the erosion and siltation that accompany urban development and the pollution stemming from urban areas have degraded watercourses, lakes, ponds, and estuaries. At the same time, construction of urban water supply systems and recreational lakes and ponds has created new bodies of water in which fish can grow.

Chapter 7 will provide more detailed information on the effects of some specific design components.

22. Aelred D. Geis, "Effects of Urbanization and Type of Urban Development on Bird Populations," pp. 97-105 in *Wildlife in an Urbanizing Environment.*

23. W. K. Figley III, "The Significance of Suburban Lagoon Developments as Waterfowl Habitat," M.S. Thesis (Syracuse: University of New York State College of Environmental Science and Forestry, 1974), 157 pp.

24. Sherman A. Minton, Jr., "The Fate of Amphibians and Reptiles in a Suburban Area," *Journal of Herpetology*, Vol. 2 (1968), pp. 113-116.

25. U.S. Department of the Interior, "Sea Turtles to Be Added to Threatened List," News Release, May 21, 1975, 2 pp.

Sediment deposits in this storm drain built less than a year ago are two feet deep in spots.

Poor design provides spaces where birds can build nests.

ADVERSE EFFECTS OF WILDLIFE

Wildlife can, under some circumstances, be a nuisance to an urban dweller or to a community. Damage can be done to gardens or to property, and there is some potential for wildlife to serve as a reservoir of certain diseases transmittable to man.

Researchers have shown that diseases such as histoplasmosis and cryptococcosis are associated with accumulations of bird droppings at blackbird roosts, bat colonies, or pigeon nests near human habitations. Also bird viruses, such as eastern, western, and St. Louis encephalitis, are seasonally present in avian populations, among which they are spread by mosquitoes, which can on occasion transmit an infection to man.[26]

Rabies is causing increased concern in many residential areas. In the past, the majority of cases diagnosed were in dogs. However, since 1956, the majority of cases have been among wildlife. Wildlife accounted for approximately 78 per cent of all cases recorded from 1970 to 1972. Of these, the greatest number occurred in skunks, followed by foxes, bats, and raccoons.[27]

Gray squirrels, although providing enjoyment to many urban and suburban residents, may at times become nuisances because of their numbers. They gnaw through lead telephone cables. They can enter homes or buildings and cause considerable damage. They can be destructive to lawns and gardens when they peel bark from ornamental trees or eat enough buds of trees and shrubs to cripple or kill the plants. They interfere with bird feeding and eat much of the food intended for birds.

They also are a potential health hazard. Although some squirrels subjected to rabies tests prove to be positive, Vagn Flyger, a long-time squirrel researcher, considers squirrels to be low-risk animals and the danger of transmitting rabies to humans from a provoked bite to be practically nil.[28]

According to Flyger, if the plague caused by *Pasteurella pestis* occurred east of the Mississippi River, in the range of the gray squirrel, fleas that occur on squirrels could be a health hazard for humans. Also, gray squirrels have been implicated in the transmission of leptospirosis. They are, at times, host to *Tinea*, the fungus causing ringworm in man and dogs; and they may be minor reservoirs for tularemia.

But, on the whole, squirrels are an insignificant hazard from a public health standpoint. In city parks, hand feeding of semitame squirrels may result in scratches and puncture wounds, but infections from squirrel bites or scratches are unusual.

As in the case of birds and squirrels, some residents provide regular handouts of food for raccoons, which are adaptable urban dwellers. However, they have become nuisances in some areas. In addition to evening raids on garbage cans, raccoons occasionally inhabit attics. Often daily harassment will persuade them to leave, and poisoning or trapping will not be necessary. Holes under the eaves of roofs should be securely screened once the raccoons depart.

An animal control specialist or anyone available to the public on animal problems will receive a multitude of complaints ranging from the mockingbird that sings too long and too loud on moonlight nights in summer, to the mole damage in the lawn, to rabbit damage in the garden. Most of the problems are relatively minor, however, and many of the complainants, if faced with the alternative of killing the offending animal or paying a price for its presence—i.e., putting up with some inconvenience—probably would choose the latter.

For example, personnel of the Texas Department of Parks and Wildlife say that many complaints are received from residents about deer eating flowers and shrubs. However, irate citizens were quick to change their attitude when asked if they wished the animal removed. They preferred to replant with species less palatable to deer.

The best way of avoiding problems with urban wildlife is, when possible, to prevent the conflicts through correct planning. For example, buildings should be constructed to exclude birds rather than trying to keep birds out after the buildings are completed; ponds should be built with muskrat-proof dams; and dumps should be kept away from airports. Programs for reducing populations of unwanted wildlife should be accomplished with authorization from respective local, state, and federal conservation agencies.

26. Louis N. Locke, "Diseases and Parasites in Urban Wildlife," p. 111 in *Wildlife in an Urbanizing Environment.*

27. Locke, "Diseases and Parasites in Urban Wildlife."

28. Vagn Flyger, "Urban Gray Squirrels: Problems, Management, and Comparisons with Forest Populations," pp. 107-113 in *Transactions, Twenty-seventh Northeast Fish and Wildlife Conference*, Contribution No. 469, 1970.

Chapter 3. Wildlife Management and Its Relationship to Planning

The guidance given in this manual for incorporating wildlife considerations into the planning process for urban and urbanizing areas is based, in large part, on generally accepted wildlife management principles and approaches. This chapter provides an understanding of these principles and the basic needs of wildlife that must be accommodated for successful integration of wildlife into the planned environment.

BASIC NEEDS OF WILDLIFE

Wildlife has four basic needs: food, cover, water, and space in which to live and reproduce. These four components collectively can be termed habitat. As we have noted, habitat requirements vary for different species.

The whitetailed deer, red-eyed vireo, and tree squirrels prefer woodlands; others, such as the cottontail rabbit and some sparrows, prefer old fields. Waterfowl are predominantly species of wetlands and bodies of water; and some species, including the common pigeon, house sparrow, and roof rat, frequently are found in the urban habitat. They all are a part of our ecosystem, and they are affected by our activities and how we deal with them and their environment.

Although many species show a strong affinity for specific types of habitat, most require a diversity of habitats for different portions of their life cycles, or to satisfy different requirements during a 24-hour period. Cover requirements may vary for nesting, raising young, resting, and protection from predators.

For example, even though deer are principally inhabitants of woodlands and brushlands, they may utilize old fields, crop fields, and woodland edges for feeding purposes. Diversity of habitat, therefore, becomes one of the key requirements in meeting the varying needs of the individual species and increasing the number of species in a given area.

Wildlife biologists call the area over which an animal ranges its home range—the area necessary to satisfy all of its requirements. This varies greatly among species and also according to the quality of the habitat. Deer may require a home range of approximately one square mile, while the fox squirrel, cottontail rabbit, valley quail, and bobwhite may be able to survive on a few acres of land.

The size and configuration of home ranges have been mapped for many species by tagging, trapping, and radio telemetry. These studies suggest that, although the spatial configuration for individuals of the same species in a given geographical area varies significantly, the size of the home range does not. This tends to indicate that home range requirements of many species can be met with a linear and irregular open space configuration similar to those present in some residential areas (i.e., wooded stream corridors).

Related to the home range is the need for wildlife to have access to the different types of habitat they require. Discontinuity of habitats can be a limiting factor for many species. This is particularly important with respect to site planning. Many residential areas contain small, disconnected woodlots. Provision of a connective open space system between these areas would encourage a greater diversity of wildlife species by making a variety of contiguous habitat types available. The lack of a connective open space system is one of the factors that limit the amount and diversity of wildlife in urban and suburban areas.

Many wildlife biologists believe that human disturbance is an important factor limiting wildlife in residential areas. The placement of design components generating high levels of human disturbance adjacent to wooded areas greatly reduces their potential use as refuges for wildlife. In developments where sufficient open space acreage and/or connective corridors to larger areas are provided, wildlife can find the seclusion needed.

Food requirements vary greatly among wildlife species. Some animals, such as the whitetailed deer, are mainly browsers of shrubs and tree twigs. Hawks and owls may prefer small mammals. Some species, like the raccoon and opossum, are omnivorous. Food preferences vary widely among songbirds. The tufted titmouse prefers insects; the cardinal, seeds, small fruits, and insects; and the cedar waxwing prefers fleshy fruits.

Preferred food items should be provided in order to maximize the retention of desired species. The type and

quantity of food weighs heavily in the wildlife composition of any given area. This can be planned for easily through protection of existing vegetation types or through supplemental planting. If preferred habitat types are provided, many species will be able to find their favorite foods within the same area.

Animals able to meet their water requirements primarily through ingestion of food are in the minority. Most wildlife species require some form of free water. In some parts of the country, water is a limiting factor for wildlife.

Fish and game departments in western states often have to provide water supplies to maintain wildlife populations at desired levels. In most parts of the country, water is not a limiting factor, especially if it is made readily accessible via a continuous open space system. Droughts such as experienced in much of the West in 1976 demonstrated the need for maintaining adequate surface water whenever possible.

WILDLIFE MANAGEMENT: PRINCIPLES AND APPROACHES

Wildlife management can be defined as the act of producing sustained annual crops of wildlife to achieve human goals, whether for recreation, aesthetic and environmental enhancement, economic or scientific values, or conservation of an endangered species. To a large extent, wildlife management is applied ecology.

As part of the planning/management process, the wildlife manager determines through various inventories what wildlife species are present, assesses their abundance, evaluates the current habitat and its potential for improvement, and attempts to determine the factor or factors limiting the abundance of wildlife. Then he sets out to do whatever is required to offset the limiting factors in order to attain the goals and objectives with respect to wildlife populations.

In doing so, the wildlife manager must recognize the potential effects of management on other land uses and resources and, for that matter, on other wildlife species if his attention is focused on a particular species of wildlife. His recommendations for management must be based upon sound biology and the environmental limitations of the area.

Those involved with managing wildlife in residential areas must consider cost-benefit ratios and people preferences if they expect their management recommendations to be implemented. Putting a dollar value on wildlife in urban areas is difficult. However, many developers and real estate agencies have learned that a house in an area characterized by natural biological communities—shrubs, trees, wetlands, and the wildlife that goes with them—will sell for a higher price than the same house on a small, barren lot.

In addition to food, water, cover, or ample living and breeding space, natural factors regulating the abundance of wildlife include predation, disease, and accidental death. Man contributes to wildlife mortality through hunting and fishing and through his fast moving cars and trains. However, his principal impact has been to alter the environment through farming, timber harvesting, livestock grazing, urbanization, and industrialization.

There are many approaches to wildlife management. These include creation of refuges, predator control, artificial stocking, transplanting of wild stock, winter feeding,

Game department's wildlife watering trough was installed in a natural setting with adequate cover for game birds.

erection of nesting structures, protection through regulation of hunting, and habitat management. Let us look at these from the standpoint of urban and suburban areas.

Generally, hunting is not permitted within the corporate limits of cities and towns. Thus, for game species like the pheasant, the outlying sections of incorporated towns may well serve as temporary refuges or sanctuaries if enough vegetation exists to provide shelter. Shooting does drive the pheasant to areas where there is no shooting.

With respect to predator control, the primary problem in urban/suburban areas probably lies with free-roaming cats and dogs. These animals take their toll of birds and animals, especially the young animals. Control can be handled best through local ordinances.

Artificial stocking ordinarily would not be attempted by an individual except for one fortunate enough to have the needed space and water for a fish pond, or except for a community fishery project. In any case, stocking should be done with the advice and consent of the state fish and game commission.

Winter feeding, especially of birds, has become very popular in this country. It may increase the carrying capacity of the area or save a few birds under extreme weather conditions, such as those experienced in the eastern part of the country in 1976–1977.

Once feeding is started in the fall, it should be continued until well into the spring when insects and other natural foods become available. Winter feeding may be of some value locally, and it contributes to people's enjoyment of wildlife; however, it probably is of little concern to the city planner.

Erection of artificial nesting structures for songbirds, waterfowl, and squirrels also may increase the carrying capacity of certain urban areas.

Hunting as a means of keeping urban deer herds under control would be prohibited in most urban/suburban areas. In the Twin Cities metropolitan area of Minnesota, however, habitat suitable for Canada geese does provide some hunting.

Habitat management is the most basic of the approaches for encouraging wildlife populations or to reduce wildlife around areas such as airports. It is on the habitat that the urban or regional planner, landscape architect, developer, and builder have the most impact. Therefore, it is primarily habitat management that we have in mind in suggesting means of incorporating provisions for wildlife enhancement in the urban planning process.

HABITAT MANAGEMENT

Of the various components of wildlife habitat, vegetation and water are, perhaps, the most essential and at the same time the most manageable. The kind, number, and distribution of plants are a major factor in the distribution of animals because, in addition to providing food, they furnish shelter and cover, protection from predators and weather, and sites for nesting, resting, perching, and breeding. Thus, vegetation and its management is basically the key to wildlife management.

The wildlife productivity of an area is largely dependent upon soil fertility; the chemical and physical makeup

and depth of the soil; and the types, amount, and distribution of vegetation produced—whether agricultural crops or other types. Soil development occurs over a long period of time; and topsoil in particular, since it is highest in fertility among the various soil layers or horizons, should be treated as a highly valuable resource. Good management, therefore, ordinarily would involve maintaining the soil fertility and avoiding the accelerated erosion caused by construction activities. Also, it would mean saving the topsoil for use elsewhere when it must be removed.

THE PLANNER AS WILDLIFE MANAGER

By now it should be apparent to the reader that the urban or regional planner, landscape architect, and developer, through their designing and construction activities, wittingly or unwittingly are wildlife managers. It is their designs that determine in large part how and where and to what extent existing habitat will be altered in the course of developing new areas or in redeveloping existing urban areas. Just as foresters, farmers, and range managers—through decisions that affect land management—have had more effect on wildlife than the combined efforts of wildlife managers, so have the planners and developers had more effect on urban wildlife than the wildlife manager.

In fact, until recently, the role of the wildlife biologist in helping to plan and manage wildlife in urban areas has been practically nil. Those efforts have been directed primarily to the control of so-called nuisance animals or to animal damage control.

There is a greater recognition, currently, that wildlife can and does enhance living conditions in urban areas. Planners, landscape architects, biologists, and ecologists need to work together to promote environmental conditions close at home that are desirable for people and wildlife alike.

Obviously, there are limitations on the extent to which this can be done, and there will be times when a compromise may be necessary. Nonetheless, there are many opportunities to do more than has been done in the past to satisfy this objective.

Wildlife managers tend to regard planning and management more as one function than does the urban planner. The planner may consider his job completed when his design has been accepted by the developer. Yet the size,

shape, and location of the open space areas will be crucial to wildlife when the plan is implemented and development occurs.

Likewise, the landscape architect may have concluded his task when he determines the number, type, and spacing of trees to be planted. Chances are, however, that not much consideration will have been given to the effects of such plantings on wildlife or to the fact the one aesthetically pleasing shrub may have little food value for wildlife, while another shrub, equally pleasing aesthetically, is excellent for wildlife.

Although the planner may have little control over how the resident in a detached home manages his lot with respect to vegetation, the planner, developer, and builder have much control over what the homeowner has to work with initially. Thus, larger lots, with as many original trees as possible and with undergrowth left intact, provide greater opportunities for wildlife management than lots in which such vegetation has been destroyed. Also, cluster-type housing developments provide greater opportunity for management because of the larger open space system provided.

Likewise, as indicated elsewhere, the style of architecture and the quality of construction have much to do with the nuisance effect of birds and animals. Therefore, management for wildlife may have to include consideration of the design components as well as the open space system.

A NEW APPROACH TO WILDLIFE PLANNING

In the field of wildlife management, there are relatively few wildlife planners. The number is increasing, however, and certainly the need for planning is recognized. Typically, the functions of a wildlife manager involve research or the use of research results; planning; the actual operation or supervision of the on-the-ground management; and evaluation of the effectiveness of management practices. Thus, perhaps, the wildlife manager works more closely with the people who carry out the plans for development than the urban or regional planner.

Better communication among planners, developers, wildlife biologists, and the public is needed, along with a holistic ecosystems approach to management. Knowledge and information that wildlife biologists and ecologists have on wildlife management and wildlife habitat should be made available to urban and regional planners. Perhaps the best way to make this input a part of urban and regional planning is to employ biologists and ecologists as members of planning teams or to secure their services as consultants. Many professional biologists and ecologists are reluctant to become involved in public affairs or matters of controversy involving the environment. As paid members of planning teams, however, they are more willing to provide needed information.

It would seem feasible, also, for environmental planning and consulting firms to include in their contracts some provisions for follow-up management of open spaces or other components related to wildlife habitat. Such work would require the services of wildlife biologists.

There are sources from which planners and landscape architects can obtain expert advice on management of wildlife in residential areas. (See Appendix A.) In addition to the many public agencies at all levels concerned with fish and wildlife and other natural resources, many professional and scientific societies are urging their members to be more active in public affairs. Some, such as the Wildlife Society, have committees that focus particularly on urban wildlife affairs. Assistance in inventorying wildlife populations in some areas may be available through local colleges and universities with programs in wildlife conservation.

Achieving communication and interchange of information between planners and biologists will require some initiative in both directions. The point is that problems whose solutions require biological information are common in urban development, and in many cases the needed information is available. Planners should recognize the need for the information and how it can be used to develop a more livable environment, and biologists should strive to make the information available in a useful form.

The remaining chapters of this manual will provide guidance on how some of the wildlife management objectives can be accomplished through planning.

A resident puts out feed for birds.

Chapter 4. Site Design for Wildlife

Future developments, of course, present planners with the greatest possibility of providing for communities rich in wildlife amenities. In these cases, decisions are yet to be made with respect to the type of housing development—cluster versus high-rise apartment versus detached single-family residences; the location and extent of open space to be retained; the routing of access roads and streets; the style and type of building construction; the sewage disposal system; and the many other aspects of an urban development. This flexibility allows for better planning approaches that set the stage for integrating wildlife in the plan.

The extent to which wildlife can exist and the degree of variation possible with different types of residential development can be inferred from observations in existing areas, even where wildlife has not been an integral component of the planning process. Within limits, for example, one familiar with the birds typical of an eastern metropolis can pretty well predict the birds likely to be present in different types of neighborhoods.

One such observer suggests that, if your only birds are chimney swifts circling in the sky by day and nighthawks zooming down at dusk, then you are a cliff dweller in the center of town.[29] If the house sparrow is the sole or dominant nesting bird, the neighborhood is likely to be one of crowded houses and pavements, little or no open space, and few or no grassy areas or shrubs. A song sparrow or a chipping sparrow, he suggests, would represent a less dense environment—pleasant lawns of some size and a sprinkling of shrubs to provide nesting cover.

The resident who sees cardinals or mockingbirds would probably be living in an area with more spacious lawns and more landscaping. The presence of young robins might be indicative of a neighborhood of grassy lawns and shade trees. Chickadees and titmice would reflect a community where older trees provide natural nesting conditions or where people are providing nest boxes. The presence of red-eyed vireos and yellow-throated vireos would proclaim a fine old neighborhood with fully grown shade trees lining the streets or scattered through the yards, while the scarlet tanager might indicate the presence of a substantial number of mature oak trees. Finally, a suburban neighborhood with wood thrushes, catbirds, or brown thrashers probably is an area of gracious trees and many shrubs, preferably with a mulch or litter around them.

A western city would have a different assortment of birds, and any city would have its own combination of birds and habitats.

Planning for wildlife can be integrated readily into conventional planning approaches. For purposes of this discussion, let us consider planning as taking place at two levels: (1) site-level design and (2) public or large-area—regional—planning.

We are defining site design as being oriented to a specific residential development project, with or without a mix of industrial/commercial facilities. At the site design scale, a more detailed approach to wildlife planning is possible, and consideration is given to the relationship of infrastructure and other design components to wildlife.

In the larger-than-site-scale level, we include all planning activities from the smallest municipal efforts to the largest regional plan. This includes city, county, state, interstate, river basin and watershed planning, and so forth. Planning for wildlife at this level is conducted on a much broader scale and focuses on the preservation and incorporation of regionally limited and/or unique habitat types in a continuous open space network.

The successful integration of wildlife is possible at both levels of planning, and we will attempt to provide some guidance to planners working at each level.

This chapter will discuss site design considerations, since they form the basis for the discussion on integrating wildlife at the regional scale. Integration of wildlife considerations into the site design process has been emphasized purposely, since this is the planning level at which the authors feel the greatest results can be achieved.

The following chapter will discuss larger-than-site-scale planning.

Two basic approaches to residential site design are commonly practiced. One is the conventional subdivision with no provision for open or common space (sometimes called "lot-by-lot" development). The other is cluster or planned unit development, more commonly referred to as

29. Barnes, "Amid Brick and Asphalt," pp. 414-424 in *Birds in Our Lives.*

PUD. Projects of this type vary in size from a few acres to the multithousand-acre new-town developments.

The PUD planning approach significantly increases the potential for wildlife amenities within the community because of the amount of open space typically provided. It also allows greater opportunities for integrating wildlife because of the flexibility in the design process and general requirements for open space, preservation of natural features, and so forth. Little opportunity for wildlife planning is provided with the conventional subdivision type of development, other than in the landscaping of individual lots. For these reasons, the guidance presented for integrating wildlife into the site design process applies only to the PUD type of development.

Planning by individual residents is not considered, although much of the information presented here can be applied by homeowners.

Ecological considerations have been incorporated into the site planning process for many years and refined through the environmental planning efforts of Lewis, McHarg, and others.[30] Wildlife has been included as one of the ecological parameters in the overall land development planning process. However, with a few exceptions, this has not been a totally integrated process resulting in communities that fully maximize benefits to be derived from wildlife.

30. Philip H. Lewis, "Nature in Our Cities," pp. 23-27 in *Man and Nature in the City* (Washington, D.C.: U.S. Department of the Interior, 1968), 92 pp.;

Ian L. McHarg, *Design with Nature* (New York: Doubleday/Natural History Press, 1969), 198 pp.

Wildlife planning must go beyond the identification of important habitats and their incorporation into the open space system. Consideration also must be given to design of the open space system, the types and locations of all design components (including infrastructure), and proposed management policies and practices.

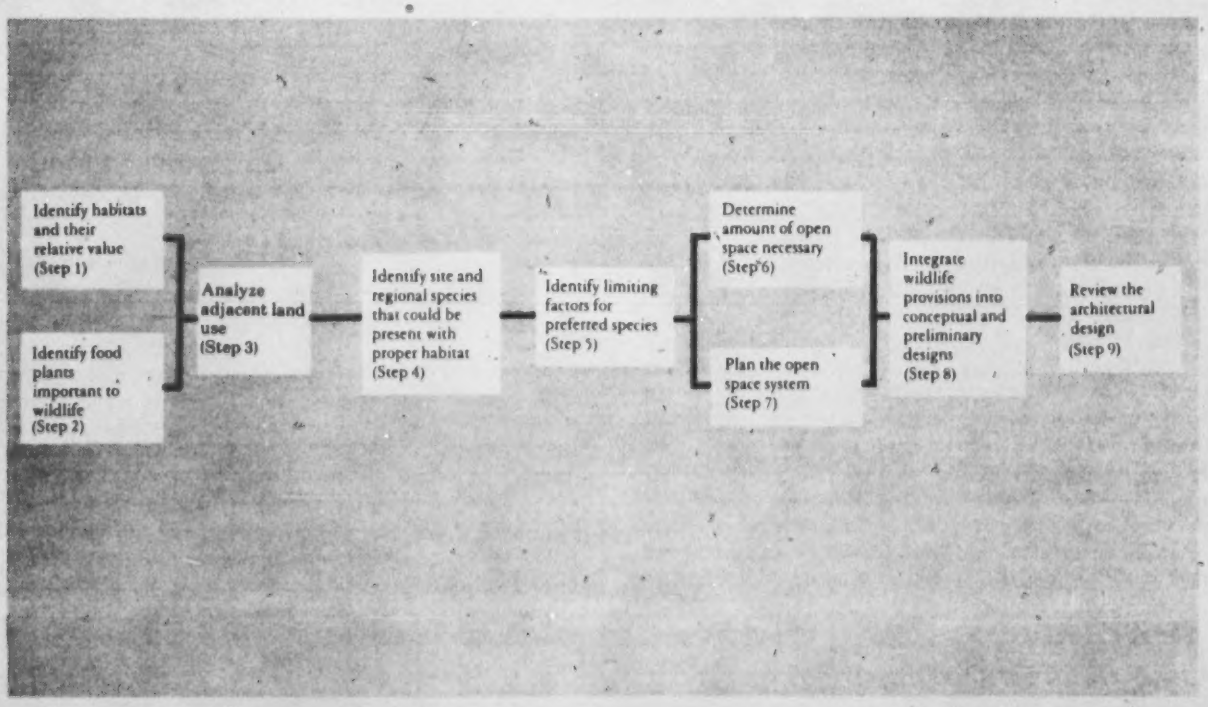
The following is an outline of a procedure for incorporating wildlife considerations into the site design process—one that does not require significant readjustment of conventional planning approaches. It begins with the identification and analysis of relative habitat types and continues through the siting of design components and architectural considerations. A deliberate attempt is made to prescribe an approach that can be accommodated by the normal complement of site designers, landscape architects, and environmental planners employed in most planning firms involved in land development.

The types of techniques and methodologies requiring a consulting wildlife biologist have been minimized or modified where possible. However, planners are urged to obtain firsthand assistance from wildlife biologists to ensure a well-integrated planning effort.

STEPS IN WILDLIFE PLANNING

The proposed methodology for wildlife planning involves the same steps as the overall site planning process: an inventory of existing conditions followed by an analysis of the findings and their incorporation into the structure of the open space system and other components of the conceptual and preliminary designs. The steps in the procedure are detailed below and summarized in Figure 1.

FIGURE 1. FLOW DIAGRAM OF PROCEDURES FOR INTEGRATING WILDLIFE CONSIDERATIONS INTO SITE DESIGN


Identify habitats and their relative value (Step 1)
Identify food plants important to wildlife (Step 2)
Analyze adjacent land use (Step 3)
Identify site and regional species that could be present with proper habitat (Step 4)
Identify limiting factors for preferred species (Step 5)
Determine amount of open space necessary (Step 6)
Plan the open space system (Step 7)
Integrate wildlife provisions into conceptual and preliminary designs (Step 8)
Review the architectural design (Step 9)

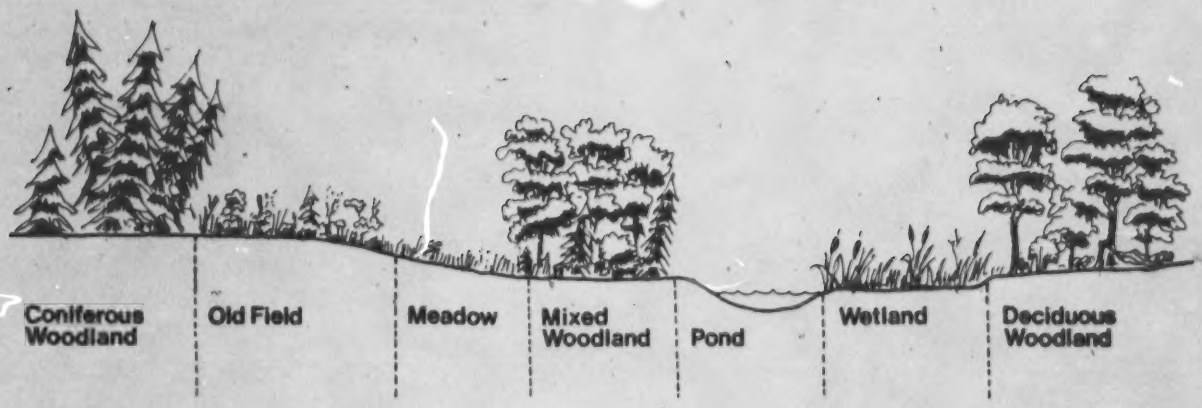


FIGURE 2. HABITAT TYPES

Step 1. Identify habitats on the site and determine their relative value for wildlife

The first step in integrating wildlife into the site design process is to determine the types of habitats that exist on the site, their relative values, and their potential for habitat development.

Each fish and wildlife species is adapted to living in a specific environment or habitat. Some species have broad tolerance to variations in soil, water, vegetation, and climate and occur in wide geographic ranges; others are restricted to rather specific ranges or habitat types. There are aquatic species and terrestrial species; species that have small home ranges; and those that require large areas to survive. Some are adapted to living in wooded areas; others to grasslands; and many prefer edges or ecotones between one type of vegetation and another. There are species or communities that are adapted for desert or semidesert areas, the high mountains, or floodplain areas.

Biotic communities of streams and rivers, lakes and reservoirs, estuaries and bays differ among themselves and from communities found on agricultural, forest, or range lands.

Habitat types for site planning can be identified, in part, from good vegetation maps. Wildlife habitats can be categorized in many ways. Individual trees can be considered as separate habitats, as can broad areas of forest or other vegetative types that may extend over several states.

The purpose of defining habitat types on a site is to distinguish between areas that differ with respect to the types of wildlife species present and/or their value to wildlife in general. Unique biological communities, particularly those containing threatened or endangered species, should be identified with the help of experts. They should be mapped and every effort made to preserve them.

Other sensitive areas, such as streams and creeks, aquifers, wetlands, woodlands, and hillsides, should be identified for protection. The American Society of Planning Officials has recommended ways that these can be protected by using the police powers invested in municipal and county governments.[31]

Representative habitat types are listed below to provide examples of the level of detail at which habitat differentiation should be defined for site planning purposes. All are typical of undeveloped sites, and each could feasibly become a component of the planning design.

Not all of the examples exist on any one site, and modificatons would have to be made to this list for different geographical areas. Further information relative to forest cover types of North America is available from the Society of American Foresters.[32] In the West, for example, rangelands or prairie grassland might be added.

1. Coniferous woodlands
   a. natural
   b. plantation
2. Deciduous woodlands
   a. beech-maple woodlands
   b. oak-hickory woodlands
3. Mixed coniferous-deciduous woodlands
4. Old fields
5. Meadows
6. Watercourses
7. Impoundments
8. Marshes
9. Wooded swamps
10. Agricultural land

31. Charles Thurow, William Toner, and Duncan Erley, *Performance Controls for Sensitive Lands: A Practical Guide for Local Administrators*, Planning Advisory Service Report No. 307/308, 1975, 186 pp. (American Society of Planning Officials, 1313 E. 60th St., Chicago, IL 60637.)

32. *Forest Cover Types of North America (Exclusive of Mexico)*, 1967, 67 pp. (Society of American Foresters, 5400 Grosvenor Lane, Washington, DC 20014.)

TABLE 1. HABITATS FOR WHICH WILDLIFE SPECIES SHOWED A STRONG AFFINITY IN THE WOODLANDS NEW-TOWN AREA OF EAST TEXAS

Habitat Types	Mammals	Reptiles and Amphibians	Birds	Total
Coniferous woodlands	16	13	87	116
Deciduous woodlands	17	12	84	113
Woodland edges	1	4	21	26
Old fields	9	9	59	77
Meadows	5	9	12	26
Ponds	0	17	29	46
Creeks	10	40	43	93
Marshes	5	20	52	77
Swamps	2	27	28	57
Lakes	2	18	40	60
Orchards	1	2	6	9
Farmland	3	2	28	33
Urban areas	4	2	5	11
Suburban areas	4	2	28	34

Source: From an unpublished 1973 study by Robert M. Maestro on design of an open space system to maximize wildlife amenities.

The relative value of the different habitat types on a site can be determined in many ways. One basic approach is to compare those present with habitat types in the general area (one-quarter to one-half mile in all directions from the edge of the site). Because of the importance of habitat diversity, those that are limited with respect to the general area should be considered of high value to wildlife. For larger sites—i.e., new-town developments—those habitat types that are limited compared to all types present on the site should be given special consideration.

Some indication of the relative value of different habitat types also can be obtained by listing the species in the region that could exist in the new community and the habitat types for which they show a strong affinity. A summary of such a compilation was prepared for the Woodlands New Town, just north of Houston, Texas. It is presented in Table 1. The numbers shown in the table represent the number of species having a strong affinity for the habitat types listed. These habitats include those that existed or could have been developed on the site. Information on species and habitat was obtained from secondary sources, such as national and regional field guides and other pertinent literature, plus consultation with local wildlife biologists.[33]

As shown on Table 1, the totals for coniferous and deciduous woodlands are approximately equal and much higher than for any of the other existing or potential habitat types. It is interesting to note that a similar analysis for Audubon, a new-town development in Amherst, New York, resulted in approximately the same relative differences between similar habitat types.[34] However, the value of either woodland type for wildlife can vary significantly according to the type and quantity of understory and the type of adjacent habitat.

33. Robert M. Maestro, unpublished data from a study of the Woodlands New-Town Development, Houston, Texas, on design of an open space system to maximize wildlife amenities, 1973.

34. Robert M. Maestro, unpublished data from a study at Audubon New Community, Amherst, New York, on design of an open space system to maximize wildlife amenities, 1973.

For example, a significant difference exists between natural coniferous woodlands and coniferous plantations. The close and uniform spacing provided by man in the latter restricts light penetration to the woodland floor. Because of the limited light available, most coniferous plantations contain very little if any understory, thereby severely limiting available cover and food. Typically, not as great a difference exists among deciduous woodlands.

However, if a choice must be made between two similar deciduous habitats which differ mainly in understory density, the one with the greater understory density should be retained. The amount of understory is particularly important for residential developments to help buffer the disturbing effects of humans and their cats and dogs.

The data from the Woodlands and Audubon new-town studies imply that maximum wildlife diversity can be achieved by maximizing coniferous and deciduous woodlands in the open space system. It should be emphasized that there would be a significant difference between woodlands adjacent to development and woodlands adjacent to another habitat type, particularly creeks, old fields, marshes, or lakes.

Woodland habitats should be analyzed with respect to their potential for understory development. Some wooded areas may have few understory species because of overgrazing by domestic livestock and/or a dense overstory. Either condition is easily mitigated—either by eliminating the livestock or selectively thinning to open the overstory. Areas that have the greatest potential for maintaining suitable understory density with minimal maintenance are those whose soils have a relatively high moisure content. Those soils are typical of floodplains as well as other areas. Wildlife benefits would be increased if a pond or two or other habitat combinations were developed within the same area.

It should be noted that there are limitations in the use of published accounts, such as field guides for determining usage of different habitat types by wildlife. Among the limitations are the manner in which the data were collected and recorded and the criteria used in identifying the cover types. Animals preferring woodland borders, for example, may have been included by some authors in strictly woodland habitats.

Likewise, practically all wildlife species require some type of free water, yet most of these were not listed under an aquatic habitat in the analysis summarized in the table. Also, coniferous woodlands are very important to many species in addition to those typical of this habitat type. Some species depend upon coniferous woodlands for shelter during severe weather conditions.

Most of the data sources utilized for the Woodlands and Audubon new towns—principally field guides—listed all habitat types in which a species can be found and did not indicate the relative affinity for each. The importance of diversity and the need of most species to utilize different habitat types for different functions or for different periods of their life cycle should be kept in mind.

Using the Woodlands study as an example, if only coniferous and deciduous woodlands were retained, with no access available to additional habitat types, the number

of different species identified for both habitat types would be significantly decreased.

Although the methodology based on the use of secondary sources may be helpful, whenever possible the planner should obtain the assistance of biologists in defining wildlife habitats present, determining their relative importance, and identifying which species may be able to be retained on the site. Often such assistance can be obtained from the regional or district wildlife biologists of the state fish and game departments, from the fisheries and wildlife department of the state university, or from the local Audubon or natural history societies. (See Appendix A, which lists sources of information and assistance, for addresses and other details.)

Step 2. Identify plant species of importance to wildlife as food sources

Plants of all types are important to wildlife, from the single-celled bacteria and algae to trees. However, in connection with urban wildlife planning, the seed-producing species are particularly important in that they provide food, cover, and nesting sites.

In Step 1, guidance was given for determining the relative value of various habitats. Identification of important habitat types forms the basis for wildlife planning, but this should be supplemented with information on specific plant species. Their value to wildlife can then be integrated with habitat selection in determining which plant species to retain and which are preferable for supplemental planting and landscaping.

The choice of habitat types must include consideration of the importance of particular plant species to wildlife. This section focuses on the food value of individual plant species. All plant parts—roots, bark, leaves, fruit, seeds, and twigs—are utilized as food by wildlife. Some biologists believe that one of the major factors in attracting seedeaters, scavengers, and birds of mixed diet to urban and suburban areas is the larger amount of available food.

This is particularly true during periods when their normal food supply is limited—e.g., during winter. Waste, refuse, and bird-feeders supply food directly, at the same time encouraging the presence of small animals that become the food source for larger species. Maintenance of lawns and gardens also provides an additional food supply as well as drinking water during dry seasons.[35]

The availability of a food source near cover should be a consideration in the identification and selection of areas for producing and raising new generations of most wildlife species. After habitat types have been selected and preserved and plant species that provide good food value to wildlife have been chosen, a community richly endowed with wildlife amenities cannot be far behind.

Many studies have been conducted by wildlife biologists on food preferences of different wildlife species. Appendix B lists by geographical region plant species of value to wildlife. It should be noted that this information represents a combined value to many different groups of

35. W. Erz, "Ecological Principles in the Urbanization of Birds," pp. 357-363 in *Proceedings of the Second Pan-African Ornithological Congress, The Ostrich*, Supplement 6 (1966).

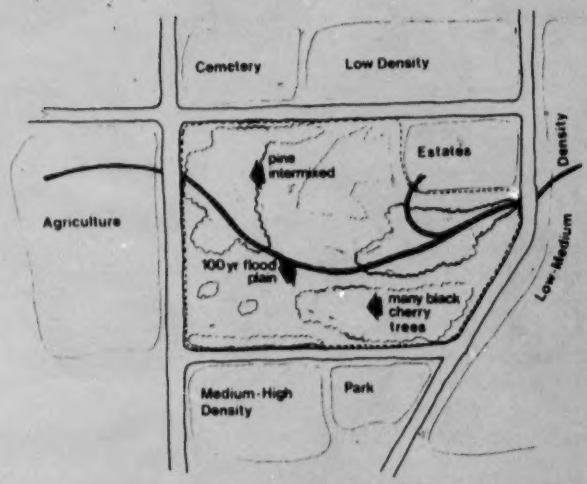


FIGURE 3. SITE SKETCH SHOWING ADJACENT LAND USES
Gray portions indicate wildlife corridors linked to surrounding areas.

wildlife, including water birds, marsh and shore birds, upland game birds, songbirds, fur and game animals, small mammals, and browsers.

Some plant species are of greater value to one group of animals than another. However, this relative rating should suffice for use by planners, particularly since wildlife planning should be directed toward maximizing a diversity of wildlife species.

Some development projects, particularly those that are too small to provide adequate open areas for many types of wildlife, may want to focus on birds. For projects of these types, planners may wish to refer to tables in *American Wildlife and Plants*, which rate food values of plant species for songbirds in addition to other groups of wildlife.[36] Other good references on plants valuable as food for birds are also available.[37]

Step 3. Analyze adjacent land uses

Planning for wildlife in relation to site development must take into consideration what exists adjacent to the site as well as on the site itself. Many additional wildlife benefits can be derived from adjoining open space areas that can serve as potential habitats or refuge areas for species on the site. Maintaining movement corridors through the site will not only enhance the potential wildlife amenities within the proposed development but also will help realize the potential for maintaining the wildlife amenities of adjacent residential areas and the region as a whole.

An existing site in its undeveloped state can not only act as a refuge area for wildlife but provide access for wild-

36. A. C. Martin, H. S. Zim, and A. L. Nelson, *American Wildlife and Plants* (New York: Dover Publications, Inc., 1951), 500 pp.

37. John K. Terres, *Songbirds in Your Garden* (New York: Hawthorn Books, Inc., 1977 (rev. ed.)), 274 pp.

V. E. Davison, *Attracting Birds: From the Prairies to the Atlantic* (New York: Thomas Y. Crowell Co., 1967), 256 pp.

life to adjacent areas if left as part of a connective open space system. Such sites need to be identified and an open space system planned so as to maintain a continuous wildlife corridor. By tying the development to adjacent open space areas, species requiring larger home ranges can be accommodated. Such open space areas could include national or state forests, natural areas, wildlife management areas, golf courses, cemeteries, parks, estates, wooded stream corridors, and so forth.

An example of the importance of considering adjacent land uses as part of the open space system for wildlife can be seen from planning efforts for the Woodlands New Town in East Texas. The W. Goodrich Jones State Forest bordered the site along its northern boundary. This state forest occupied approximately 500 acres and, because of the experimental harvesting methods utilized, contained a variety of prime wildlife habitats.

Thus, a link with the forest was of great value since it could act as a refuge area for wildlife, supplement habitats existing on the site, and encourage wildlife to move into the new town. It would become even more important once areas adjacent to the site became developed in response to the presence of the new town.

Step 4. Identify species on the site and in the region that could be present if proper habitat were provided

Although various methods have been devised for determining the types and populations of wildlife existing in an area, their application usually requires trained biologists or people working under the supervision of such biologists. When budgetary and scheduling constraints do not permit the use of biologists, secondary data sources can be used, and local naturalists or fish and wildlife biologists can be contacted regarding the availability of source materials and for help in interpreting the information.

Regional and national species lists and field guides exist for birds, reptiles, amphibians, mammals, and fish. These give broad geographical ranges for each species along with the description of their habitat types. The process then basically becomes one of listing those species whose geographical range includes the proposed site and for which preferred habitats exist either on or adjacent to the site or which can be provided (e.g., ponds and lakes).

For many sites, it may suffice to list only those species identified as common or frequent inhabitants. The planner should be alert, however, to the possibility that the development may further endanger threatened species and should take every precaution possible to preserve their habitat.

The conversion of an undeveloped area into a residential area will further decrease the amount and types of critical habitat available. However, when site planning provides for development of ponds, lakes, or other habitats that presently are limited in the area, species adapted to such habitats can be benefited.

Step 5. Identify limiting factors for preferred species

Although identifying and retaining habitats for preferred species can result in their increased production, it also can result in a decrease of other wildlife. Each individual species or group of species has its own particular requirements that must be satisfied to ensure its retention within the proposed development.

Performing the previous steps does not guarantee that specific species will be retained in desired densities or that they will be retained at all. In order to ensure retention of individual species or groups of species, the existing conditions within the site must be analyzed in relation to the specific requirements of the species. Any limiting factors must be identified and methods prescribed for their incorporation into the design or management system for the proposed development.

The wildlife planning study for the Woodlands New Town represents a good example of defining limiting factors.[38] Bobwhite quail were present in the region and were desirable. However, very few quail existed on the site in its undeveloped stage. Discussions with wildlife biologists of the state fish and game department revealed

38. Maestro, unpublished study of the Woodlands New Town development.

Pennypack Park, part of Philadelphia's park system, provides a narrow strip of parkland in the midst of urban expansion.

Stream corridor and wooded area surrounding development serve as a wildlife sanctuary and primary corridor.

that food was the limiting factor. The site was predominantly wooded, and the tree canopy restricted the amount of light available for understory food plants.

Specifications were proposed for integration with the open space management program to provide the required food sources through plantings and by allowing woodland edges to develop natural shrubby growth. Areas best suited to food plantings were determined from an analysis of soil data. Soils with a relatively good moisture content and relatively high natural fertility were determined to produce the best sustained yields with minimal maintenance. These same criteria generally apply for food plots in all geographical areas.

The availability of grit as a factor affecting mourning doves presents another good example. Mourning doves are desirable species to retain within residential areas; they are aesthetically pleasing, and their cooing call is pleasant to hear. Grit is important in their diet and may be a dependent factor in population distribution of the species.

The type of grit also is important. Very small stream-washed gravel should be available—not crushed stone—to satisfy their needs, and it can be scattered along roads, trails, or other suitable areas if it does not occur naturally on the site.

Since it is impractical to define here the limiting factors for all species, local wildlife biologists should be contacted for assistance in each project.

Step 6. Determine how much open space is necessary

The amount of open space required is difficult to determine. As indicated earlier, each species has a home range within which it satisfies all of its requirements. Although the home range of many species in the wild has been defined, little knowledge presently exists on how much area these same species would require in order to be retained within developed areas.

It is apparent, however, that home range requirements can be accommodated on urban sites for some species. Raccoons, for example, can survive with smaller home ranges in urban and suburban areas than under more natural conditions, presumably due to a readily available food supply in the form of garbage.[39]

Birds seem to adapt better to residential developments than some other species. This is fortunate because songbirds are perhaps the most desirable wildlife species in residential areas. A study in northern Delaware related the size and characteristics of nine urban woodlots to the diversity of breeding birds. The investigators concluded that dense populations of a large variety of breeding birds are found in urban woodlots of 20 or more acres, but that size alone will not guarantee large numbers and diversity.

Compositional characteristics also are important. The researchers suggested that the woodlots should have adequate shrub understory, mature and dead standing trees, and vegetative edge types that are of sufficient width and proper quality.[40] A linear configuration, typical of wooded tracts in many residential areas, is well suited to songbirds, since it provides much edge.

39. J. R. Schinner and D. L. Cauley, "The Ecology of Urban Raccoons in Cincinnati, Ohio," pp. 125–130 in *Wildlife in an Urbanizing Environment.*

40. John T. Linehan, R. E. Jones, and J. R. Longcore, "Breeding-Bird Populations in Delaware's Urban Woodlots," *Audubon Field Notes,* December 1967, pp. 641–646.

One of the main factors influencing home range requirements within residential areas is the effect of human disturbance. Species such as the raccoon, many songbirds, and the gray squirrel have adapted well to the presence of humans; many other species are more sensitive. To help ensure the retention of the latter species, acreage greater than that required under natural conditions should be provided to buffer against human disturbance.

Unfortunately, it is impractical for many reasons to list the home range for all wildlife species. For one, data either do not exist for all species or the samples taken have been too few to be conclusive. Determinations made for a species in one geographical area may not be applicable for other parts of the country, and the size of a home range for any one species in a given area may vary greatly according to the conditions present.

Attempts to retain deer in the Woodlands New Town represent a good example of the problem. Data were readily available on home range requirements of deer in the region, including areas that had habitat very similar to that on the proposed new-town site. However, the determination of how much open space would be necessary to retain deer within a 20,000-acre new town containing more than 100,000 people could not be supported with any research data.

An open space wildlife corridor system averaging 600 feet in width was recommended, based on the subjective consensus of prominent wildlife biologists and researchers from the Southern Forestry Experiment Station of the U.S. Forest Service, the Texas Parks and Wildlife Department, Texas A & M University, and others.[41]

Thus, while no absolute answer can be given as to how much area is required until further research data are available, it can only be assumed that the larger and more diverse the open space is within a developed area, the more wildlife there is likely to be. As indicated previously, this acreage can be maximized by connecting the open space system with undeveloped areas adjacent to the site.

Also, size requirements can be compensated for to a certain degree by concentrating efforts toward providing high quality habitat. This can be achieved by proper selection of habitat types to be retained in communal open space areas and by taking into consideration the limiting factors of preferred species. It should be apparent, also, that the way residents of an area manage the vegetation on their individual lots will have a bearing on the wildlife in the community.

Step 7. Plan the open space system

Once the existing conditions that affect wildlife have been identified on site and within the adjacent area, one can proceed to integrate wildlife into the design of the open space system. In most cases, it will be impossible to incorporate all of the habitat types identified earlier. Frequently, these habitats would occupy greater acreage than it is economically feasible to retain. Also, they may coincide with the areas that are preferable for development or use as recreation areas.

Therefore, the integration of wildlife habitats into the open space design must begin with those areas that normally would be retained, irrespective of wildlife. These include floodplains, steep slopes, wetlands, utility line and road rights-of-way, and other areas intrinsically unsuitable or economically undesirable for development.

However, once the basic structure of the open space system is formulated, additional habitat types can be integrated, either as recreational/aesthetic components (e.g., ponds and lakes) or as part of the more detailed

41. Maestro, unpublished study of the Woodlands New-Town development.

Allentown, Pennsylvania, has developed parks on most of its floodplains, shown here under rising waters. Flooding in the urban center has been eliminated.

planning associated with the design components.[42] Also, special landscaping techniques can be applied to large and small open space areas to increase their value to wildlife.

The areas most likely to remain undeveloped must form the spatial framework for wildlife. The task now becomes one of analyzing this acreage to see what modifications/additions can be made in light of the knowledge obtained in Steps 1 through 6. It is recognized that certain limitations exist that bear on the amount and location of open space that can be retained. The areas defined in Step 1 as valuable to wildlife must be integrated into this framework as well as possible within the limitations imposed.[43] This task naturally becomes more difficult as the amount of land most likely to remain undeveloped approaches the per cent of open space allowable.

Before we discuss potential modifications to the open space framework, let us consider the value of the land remaining undeveloped in residential areas. One should not assume that these areas have limited value to wildlife simply because wildlife is not a consideration in their retention. Quite the opposite is true, particularly in the case of wooded or semiwooded floodplains, which are typical in most areas.

As indicated in Table 1, more species of wildlife show a strong affinity for woodlands than for any other habitat. This would hold true for wooded or semiwooded floodplains as well. In many ways, wooded floodplains are of even greater value to wildlife than upland woodlands since the water provides an additional habitat type, thereby increasing the potential wildlife.

The ecotone formed between the aquatic and woodland habitats provides additional benefits to wildlife. The soil moisture available in floodplains frequently allows for more luxurious growth of understory species, thereby providing additional cover and screening from human disturbance.

In utilizing the undevelopable land, the first thing is to see whether it is a continuous open space/wildlife corridor system that is connnected with adjacent open space parcels.[44] If it is not, interconnecting parcels of open space should be incorporated. The most valuable habitats and groups of plant species should be used. As many corridors as possible should be provided through the site. Frequently, many are possible because of the existence of streams and related floodplains.

Where these are minimal or nonexistent, primary consideration should be given to maintaining continuity with any corridor presently existing within the immediate area and contiguous with the site.

Where possible, efforts should be directed toward developing or retaining at least two major corridor systems that are generally perpendicular to each other and meeting near the center of the site. The purpose of this type of

42. Robert M. Maestro, "The Incorporation of Wildlife into the New-Town Planning Process," pp. 155–157 in *Wildlife in an Urbanizing Environment.*

43. Maestro, "The Incorporation of Wildlife into the New-Town Planning Process."

44. Maestro, unpublished study of the Woodlands New-Town development.

The multiflora rose living fence provides a wildlife corridor as well as screening and restricting access.

system is to make an equitable distribution of wildlife amenities throughout the proposed development.

All corridors do not have to be equal in width, but at least one major corridor should be provided. It should be selected as the one that connects with the largest undeveloped tracts of land adjacent to the site. The primary corridor can then be supplemented with secondary and tertiary corridors of small size.[45] These ancillary corridors extend from the major system into and through the site, encouraging the movement of wildlife into and through residential areas. The tertiary corridors may be only a row of trees or shrubs along a road right-of-way or a drainage swale allowed to undergo natural succession. They may be of value primarily to squirrels and songbirds.

The corridors should be predominantly wooded or have dense shrubbery to help buffer the effects of human disturbance. Portions that presently are not wooded, particularly those bordering watercourses, should be planted with tree species selected from the list in Appendix B or allowed to undergo natural succession to mature woodland. Often the latter is preferable.

Only the primary and possibly some of the secondary corridors can be defined at the early planning stages. The tertiary corridors and at least some of the secondary corridors will have to be defined more practically as the preliminary design plans are developed. Their integration probably will continue into the final design stages.

Planning the open space system of a site for which an open space framework already exists—stream corridors with attendant floodplains, wetlands, steep slopes, and so forth—calls for a different approach than a site where few preexisting determinants are present. In this first case, little opportunity may exist for incorporating additional preferred habitats.

As mentioned previously, the amount of latitude available is dependent upon what percentage the prede-

45. Maestro, "The Incorporation of Wildlife into the New-Town Planning Process."

Wildlife field border consists of a double row of autumn olive and honeysuckle. The grass provides food and cover for songbirds, pheasants, and small game.

termined open space represents compared to the amount allowable economically. Any difference should be augmented with the most valuable habitats that remain. If the total acreage allocated for open space is already appropriated, a readjustment in unit densities can be justified if the additional acreage can be demonstrated to improve wildlife amenities significantly for the development.

The Woodlands New Town in Texas again furnishes a good example. The site and surrounding region were covered with shortleaf and loblolly pine forests. The extensive floodplain system and utility rights-of-way took up practically all of the open space acreage allowable. However, one area, consisting of a variety of mature oaks, was present adjacent to one of the floodplains. The value of this area to wildlife and its importance as a food supply was demonstrated and the area was retained.[46] Often the significance of additional acreage can be justified if the area is a unique habitat type or a valuable food source, based upon information present in Appendix B.

For all wooded components of the open space system, the importance of understory density, discussed in Step 1, should be kept in mind. Where it is not practical to incorporate wooded areas with a relatively dense understory, the shrub layer can be increased either through supplemental plantings or by opening the overstory canopy if light restriction is the causal factor. Often, evergreen shrubs are preferable for supplemental planting because they provide cover and screening all year. Additionally, evergreens are effective at reducing noise levels in urban areas.

Once the basic open space system is established, many opportunities exist for integrating additional habitats into the design process. Some of these are quite obvious and are frequently included as part of the overall design; others are much less obvious and frequently are overlooked.

Ponds, lakes, and retention basins are examples of the more obvious design components. If planned and designed properly, they can increase potential wildlife benefits within a community significantly by increasing habitat diversity.

For maximum utilization by wildlife, impoundments should be incorporated into or adjacent to the open space system. Those surrounded completely by developed areas offer few wildlife amenities. To provide use by both humans and wildlife, medium- or high-density development can be accommodated along one side of the impoundment if the open space system or very low density housing borders the opposite side. The utilization of impoundments by wildlife is also dependent upon design, as will be discussed in Chapter 7.

It may be difficult to justify the retention of old fields in developing site plans. Typically, these represent prime areas for development. However, old fields are very valuable to many wildlife species. Because of the ecotone provided, their value is significantly increased when they are adjacent to wooded areas.

Many opportunities exist for integrating old fields within the site. Road rights-of-way adjacent to the open space system are an excellent example. Allowing these areas to undergo natural succession not only benefits wildlife but also reduces maintenance costs. A border of approximately 20 feet adjacent to all other portions of the wooded open space system also should be allowed to develop naturally into the vegetation typical of old fields.

The same practice can apply to utility rights-of-way and borders of drainage swales if mowing or selective herbiciding is done only once every two to five years. Even though these areas will be relatively narrow, their value to wildlife is significant.

46. Maestro, unpublished study of the Woodlands New Town development.

The landscaping efforts normally performed by the planning firm also can significantly supplement benefits derived from the open space system. The presence of properly selected trees on the borders of roads, for example, can increase songbird diversity and numbers.

Step 8. Integrate wildlife considerations into the conceptual and preliminary designs

Thus far, guidance has been given on how to structure the open space system to derive maximum benefits for wildlife. Although this may be considered as a major accomplishment, the process should not end here.

The relationship of the design components to the open space also is an important consideration. Many of the wildlife benefits anticipated in the planning stage may not be realized if wildlife considerations are not carried through into the design process.

In this section, basic wildlife planning concepts are discussed with respect to typical design components—roads, commercial and industrial facilities, outdoor recreation, and housing units. The level of detail at which each is discussed varies according to its relative importance with respect to wildlife and the amount of information available. More detail is presented for some specific areas of concern in Chapter 7.

Two major areas of concern must be addressed with respect to the design components. These are (1) minimizing adverse physical impacts on components of the open space system that are important to wildlife and (2) minimizing the effects of human disturbance.

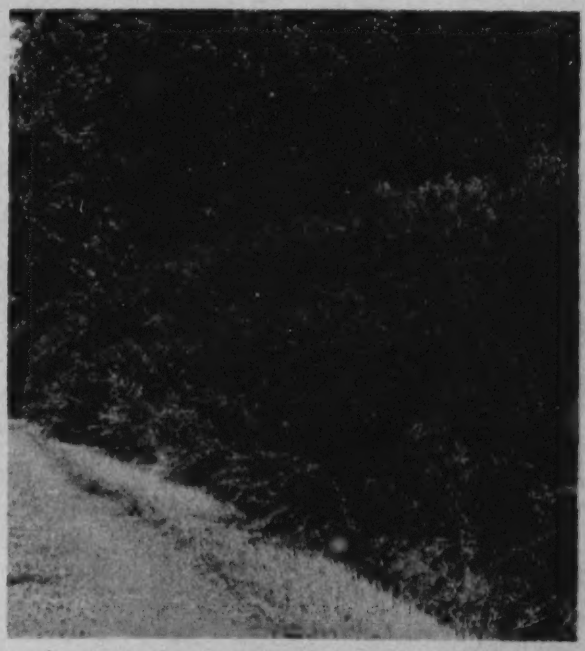
Minimizing Physical Impacts

As a very basic rule of thumb, all efforts should be made to minimize adverse impacts on any component of the open space system. Particular care must be taken to minimize any breaks in the open space/wildlife corridor system, particularly those caused by roads and highways. It is recognized that most roads designed in association with site planning serve some type of development on both sides. In some cases, such as entrance roads to the development, freeway extensions, and segments of major arterials, efforts should be made to align road segments in such a way as to help buffer human disturbance to refuge areas and to restrict access.

Where crossing the open space system cannot be avoided, roads should be planned in areas where the open space system is narrow. Large wooded areas should be kept intact to maximize their utility as refuge or sanctuary areas. Overpasses or underpasses should be considered to facilitate wildlife movement.

Road width plays an important role with respect to wildlife. A study on the effects of roads on the movement of small and medium-sized mammals in forested areas suggested that divided highways of 90 or more meters (293 feet) in width may provide a barrier to movement comparable to a water body of 180 meters (585 feet).[47] Therefore, all efforts should be made to minimize crossing the open space system with major roads.

47. D. J. Oxley, M. B. Fenton, and G. R. Carmody, "The Effects of Roads on Population of Small Mammals," *Journal of Applied Ecology*, Volume 11 (1974), pp. 51–59.



Bicolor lespedeza, a legume, is useful for controlling erosion and providing food for wildlife.

Where roads cross watercourses, culverts also may act as barriers to movement by reptiles, amphibians, fish, and small mammals. Where the use of culverts cannot be avoided, they should be oversized or located so as to permit animal passage.

Minimizing Disturbances

The reactions of wildlife to human disturbances such as noise and physical activities vary. Continuous noise and movement has little effect on most species, whereas discontinuous or intermittent types of disturbance may greatly affect wild animals. For example, most species can be approached quite closely by a moving vehicle. They will remain nearby as long as the motor continues to run and the occupants do not make sudden moves. But, as soon as the motor is shut off and someone gets out of the vehicle or the car door is slammed, the animal will make a quick exit.

In planning the areas surrounding an open space system, those components generating disturbances of an intermittent and discontinuous nature are of greatest concern, whereas those whose disturbance factor is more or less continuous are of less concern. Housing units and outdoor recreation activities are examples of the former; roads and highways represent the latter, even though traffic causes considerable wildlife mortality.

Different housing types generate different levels of disturbance. It is safe to assume that the major cause of disturbance is associated with children and dogs and cats. Therefore, housing types producing the greatest concentration of children and pets represent the major area of concern. The high-bedroom-count units (single-family detached and large townhouses) typically contain the largest number of children and pets per unit. Low-bedroom

count units and units for the elderly generate the least disturbance.

Garden and high-rise apartments, although typically containing much smaller bedroom-count units, may produce similar concentrations of children and pets simply because of the larger number of units per area. However, most of the children in this kind of housing are typically much younger and therefore more confined in their activities. It also has been observed that people of all ages in apartments, particularly high-rise, tend to make less use of adjacent natural open space than those in single-family homes.

In addition, although the concentration of pets per unit also may be higher, they generally are more confined. When allowed outdoors, their activities are more likely controlled. In single-family-home developments, there is more tendency to allow pets to roam freely.

Concern for human disturbance therefore focuses on high-bedroom-count single-family units. Townhouses with comparable bedroom counts are of greater concern than single-family detached homes, particularly those on larger lots, because of the greater number of individuals per acre. Also, single-family detached homes typically have more property, which helps to buffer the effects of disturbances.

Given the fact that certain types of housing developments do not mix well with wildlife, it is desirable for planners and developers to consider what actions can be taken. Enactment and/or enforcement of laws to prohibit pets from roaming and educational campaigns to inform people about the impact they may have on wildlife are possibilities.

The planting of thorny vegetation along borders may be sufficient to discourage activities of children in areas of particular value to wildlife. At the same time, well-developed nature trails may enable children and their parents to derive benefits from the wildlife. Trails should be elevated over wet areas to avoid disturbance of the vegetation. The posting of signs explaining why tortoises and other animals should not be collected for pets would be helpful.

Most types of commercial, office, and industrial facilities are design components that pose less disturbance for wildlife in the adjacent open space system. Although much activity may be generated at commercial areas, the noise level is generally low; and little of the activity affects adjacent open space areas. Commercial development therefore may help buffer the larger refuge components of the open space system.

The effects on wildlife can be minimized for small commercial facilities by placing all parking in front of the buildings. For larger commercial areas—mini-malls and malls—it is preferable to separate the buildings from the open space system with parking. The fringes of the parking areas in these larger commercial facilities are used infrequently and therefore act as buffers for the open space.

Industrial facilities vary greatly in the amount of disturbance generated. Those typically integrated into planned unit developments are of the "clean industry" variety and can be considered in the same light as the commerical facilities discussed above. Because of their buffering effect, employee parking areas can be placed between the open space system and the buildings.

Those types of recreation units—i.e., playgrounds or baseball lots—that have the greatest potential for generating human disturbance should not be located adjacent to the most sensitive components of the open space system. It is difficult to say what parts of an open space system would be more sensitive to human disturbance. The existing literature provides little guidance in this area. However, it seems reasonable to conclude that the larger wooded areas are the most sensitive since they have the greatest potential for serving as refuge areas for wildlife. The more they can be protected, the more likely they will be to function in this capacity.

The narrower portions will support some songbirds and small mammals and also will function as travel corridors for other species.

Step 9. Review the architectural design

Although architectural design is not normally considered as part of the site planning process, for wildlife planning purposes certain principles should be con-

Pigeons, being nonmigratory, have an advantage in the competition for nest sites. Architectural design thus is a factor in preventing pest birds.

sidered. Architectural design is related to the bird population of any developed area. Even if full consideration is given to wildlife in planning the open space system, the design components, and site improvements, a bird population dominated by such pest species as pigeons, starlings, and house sparrows may still result. For this reason, architectural design also should be considered in the wildlife planning process.

Among the reasons suggested for the success of pigeons, starlings, and house sparrows are that they are all birds characteristic of urban areas in the Old World, where they had time to acclimate to such conditions; and they all are either hole nesters or they build their nests in crevices of buildings, where they are protected from predation and accidental disturbance of the nest. They generally are nonmigratory, which gives them an advantage over migratory species in the competition for nest sites; and there is less seasonal fluctuation in the availability of food in cities than in other habitats.[48]

The ability of these birds to use buildings can be attributed sometimes to the design of the buildings and sometimes to poor construction. Some commercial and residential buildings have proved to be excellent roosting and/or nesting sites. Certain sections of new communities, with buildings of one type of design or construction, may harbor one or more of these three species, whereas other sections of the same new community may have few of them.

Buildings with unboxed eaves having small openings beneath the roof afford starlings and house sparrows access to attractive nest sites. A recent study conducted in Columbia, Maryland, showed that these birds were able to remove some of the fine wire screening that covered air vents and use these protected sites for nesting. Heavy screening on vent holes kept the birds out, but frequently building flaws allowed continued access elsewhere on some buildings. Louvered air vents also resulted in increased house sparrow populations, and vents of fans were associated with large numbers of nesting starlings.

Pigeons also moved into some apartment and commercial areas in Columbia in great numbers. Overhanging portions of some of these buildings were supported by large exposed I-beams that provided roosting and nesting sites. The population of these nuisance birds could have been reduced significantly if wildlife had been considered in developing the architectural design.[49]

Some researchers believe that the increased use of reflective plate glass on buildings may account for the death of many birds. When reflective glass is used on buildings in wooded areas, birds in flight have the illusion of additional trees or woods where the buildings stand because of the reflection of the trees. Examples of such bird mortality already have been noted at the John S. Lehmann Building in St. Louis and at several buildings with reflective plate glass in Washington, D.C.[50]

REVIEW OF DEVELOPMENT PLANS

Municipal planners also can help preserve wildlife amenities through review of site development plans. It is at the site plan review stage that the greatest concessions favoring wildlife can be obtained, since developers are likely to be willing to accommodate changes in order to obtain permits.

When reviewing development plans, municipal planners should use the steps outlined above for incorporating wildlife into the site design process, with one addition. If regional planning efforts have included consideration of wildlife, the site plan should be reviewed in light of these plans. This includes determining whether the site contains habitats of threatened or endangered species and regionally limited or unique habitat types and whether there is any linkage with regionally defined open space corridors.

The plans then should be reviewed to ensure that valuable habitats on the site have not been eliminated in favor of others of lesser value, that a continuous open space system has been provided wherever possible, and that the design is sensitive to the effects of human disturbances on wildlife.

Finally, the detailed design should be reviewed for such things as tree and shrub plantings of value to wildlife. (See Appendix B.) Such plantings would substitute, in part, for natural forest areas that have been eliminated or made less valuable by having the understory cleared. The review should involve consideration of impoundments of benefit to fish and wildlife. The developer should be alerted to the possible detrimental effects of developments on streams.

The proposed architectural design can be discussed also, to make the developer aware of the potential effects it can have on nuisance bird populations.

48. Wayne C. Weber, *Birds in Cities: A Study of Populations, Foraging, Ecology, and Nest-Sites of Urban Birds*, M.Sc. Thesis (Vancouver: University of British Columbia, 1972), 269 pp.

49. Aelred Geis, *Effects of Building Design and Quality on Nuisance Bird Problems*; Paper presented at Seventh Vertebrate Pest Conference, Monterey, California, 1976. (Proceedings of the conference are expected to be published in 1978.)

50. Richard C. Banks, "Reflective Plate Glass: A Hazard to Migrating Birds," *BioScience*, Vol. 26(6) (1976), p. 414. (American Institute of Biological Sciences, 1401 Wilson Blvd., Arlington, VA 22209.)

The den tree plays an important part in wildlife management and should be preserved. A succession of animals may occupy it.

Chapter 5. Wildlife and Larger-than-Site-Scale Planning

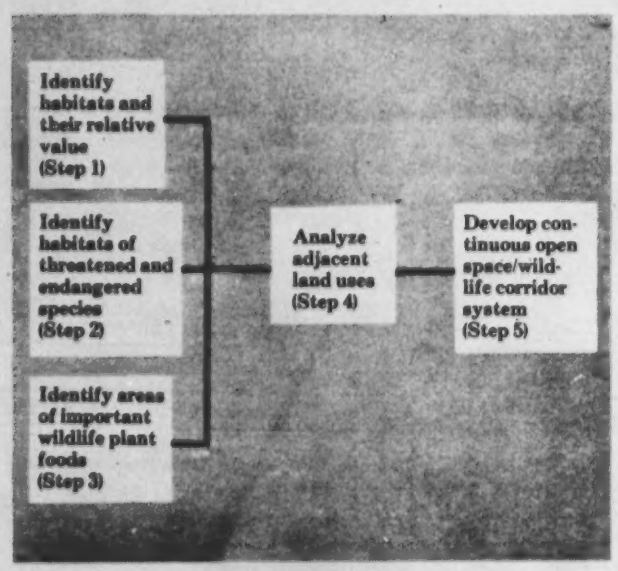
This chapter will discuss the incorporation of wildlife amenities into larger-than-site-scale planning, the kind of planning typically carried out by municipal planning departments, county and regional planning commissions, watershed associations, conservation commissions, and state and interstate groups.

The incorporation of wildlife planning into municipal planning activities is emphasized because it is felt that greater implementation can be achieved here than at the larger state and interstate scales. The municipal level has been emphasized, also, because this is an area where more guidance is needed in wildlife planning.

STEPS IN WILDLIFE PLANNING

Planners in the past have shown varying degrees of concern for wildlife in their plans. Environmental inventories with sections on wildlife are made at every level of government as background for planning. In most cases, however, the wildlife inventories have been somewhat general, and often there has been little follow-through to ensure the benefits that can be realized by incorporating specific provisions for wildlife in plans and designs.

FIGURE 4. FLOW DIAGRAM OF BASIC WILDLIFE PLANNING PROCEDURES AT THE REGIONAL LEVEL


Identify habitats and their relative value (Step 1)
Identify habitats of threatened and endangered species (Step 2)
Identify areas of important wildlife plant foods (Step 3)
Analyze adjacent land uses (Step 4)
Develop continuous open space/wildlife corridor system (Step 5)

In regional planning, wildlife considerations focus mainly on preservation. A major function of large-scale planning should be to identify key wildlife areas that should be kept free of any type of land development. Major consideration should be given to maintaining a continuous open space/wildlife corridor system throughout the area.

The material here follows many of the principles outlined in the previous chapter on site design and therefore is presented in briefer fashion.

Step 1. Identify habitats and determine their relative value for wildlife

As with site design, one of the first steps is identification of the habitats to be preserved. On a regional scale, maintenance of diversity of habitats is a prime consideration in preserving ecological stability.

In order to maximize diversity, the limited and/or unique habitat types of the region must be preserved. In addition to their importance for wildlife, these areas also are of value for educational and scientific purposes. Frequently, limited and/or unique habitat areas are occupied by threatened and endangered plant and animal species.

Defining limited or unique habitats is a relatively simple process. Ideally, such a determination can be made on the basis of a detailed vegetation map and with the assistance of local terrestrial ecologists or naturalists.

Even without the use of a vegetation map, much information can be derived from aerial photographs. Little training is needed to distinguish pockets of coniferous woodland in a region dominated by deciduous forests; or vice versa. Bogs and marshes also are readily discernible in areas where they are scarce.

Aerial photos are readily available to planners. With the assistance of locally knowledgeable individuals— staff of the U.S. Fish and Wildlife Service, U.S. Forest Service, or U.S. Soil Conservation Service, for example--areas of interest can be identified readily, often at no expense.

In addition, the relative value of all of the remaining habitats should be evaluated. Ordinarily, an open space/

wildlife corridor system cannot be constructed solely of unique habitat types. Other areas must be included to make the system a continuous one. The guidance given under Step 1 of the previous chapter should assist the planner in determining the relative value of these habitats.

Additional factors come into play at the regional scale, however, and they may significantly change the relative rating of habitats for key wildlife species. For example, in mountainous regions that typically receive heavy snowfall, foothill areas, particularly southerly slopes, become critical to deer as winter feeding areas. The lack of suitable winter feeding grounds has been shown to be a limiting factor for deer in many areas. Development of such areas could significantly influence the population dynamics of local deer herds.

Similar examples exist for other species. Therefore, it becomes important to use the services of wildlife biologists in evaluating wildlife habitats for larger-scale planning.

Step 2. Identify habitats of threatened and endangered species

Threatened and endangered species were not discussed under site design because it should be the responsibility of the regional planning agency, not the site designer, to identify these species and their habitats. This information then can be taken into consideration in choosing areas for development, rather than waiting for a developer to make a major investment on a parcel of land before such determinations are made.

Environmental impact statement (EIS) requirements under the National Environmental Policy Act (NEPA) include identification of threatened or endangered plant and animal species. Regional planners should give consideration to protection of these species to help ensure their survival for future generations.

Ideally, field surveys should be conducted to identify the presence of such species in the region; but budget restrictions may force reliance on secondary sources.

Assistance can be provided by the U.S. Fish and Wildlife Service, the state fish and game department, and local naturalists. In many areas, the state museum is the repository of this information. Often, local conservation groups, such as a chapter of the Audubon Society, can be of great assistance.

Step 3. Identify groups of plant species of value to wildlife

As indicated in Step 2 of the previous chapter, the retention of plant species that are valuable as food supply can add measurably to the wildlife in an area. The rankings of plants as food for wildlife given in Appendix B should be used in selecting habitats. The ranking for each species represents a combined weighting for all types of wildlife species.

For site design, one may wish to refer to the original source of this appendix to obtain listings weighted for specific groups of wildlife, such as songbirds, that are more typical of residential developments.[51] However, for larger-scale planning efforts, the listing in Appendix B is more appropriate. On a regional basis, maintenance of a wider diversity of wildlife species is possible because of the relatively large amount of open space provided and because of the potentially greater diversity of habitats offered.

Step 4. Analyze adjacent land uses

As is the case with site planning, adjacent land uses should be taken into consideration in any regional planning effort. Large, permanent, open space areas immediately adjacent to the planning area—state and national forests and parks and conservancy lands—should be hooked up with the corridor system. This increases the habitats available and ensures better access throughout the region, although isolated areas may be valuable.

Step 5. Develop a continuous open space/wildlife corridor system

Once a ranking of habitats and plant communities is developed, those of greatest value should be integrated into a continuous open space system to help facilitate movement of wildlife throughout the region. Much useful information on environmental corridors has been developed by Lewis in his book *Regional Design for Human Impact.*[52] Most of the guidance given earlier for site design is applicable to regional planning efforts and, therefore, will not be repeated.

The corridor system should be based, in part, on the floodplains present. Regulations already exist in most parts of the country for retaining these areas in open space, and in many cases the network of floodplains is well distributed throughout the region. Any key parcel of wildlife habitat not contained within the floodplain should, if possible, be included by regulation, leasing, or acquisition.

On the regional scale, efforts should be directed toward maximizing retention of large areas interconnected by smaller corridors. This "string-of-pearls" or "open space net" effect will help ensure retention of most species in the region, even those with large home-range requirements.[53]

THE USE OF REGULATORY CONTROLS

Any regulation that preserves open space or controls the types of uses allowable in open space areas can benefit wildlife.

Since most planners are well aware of these control mechanisms, we will summarize their application to wildlife preservation briefly.

The most common types of regulatory mechanisms are zoning and land development ordinances, particularly the performance controls built into land development ordinance packages. Ordinances are presently utilized by some municipalities for floodplains, steep slopes, wood-

51. Martin, Zim, and Nelson, *American Wildlife and Plants.*

52. Philip Lewis, *Regional Design for Human Impact* (Kaukauna, Wis.: Thomas Publications, 1969), 307 pp.

53. Fred H. Bair, Jr., *The Open Space Net,* Planning Advisory Service Report No. 230, 1968, 24 pp. (American Society of Planning Officials, 1313 E. 60th St., Chicago, IL 60637.)

lands, wetlands, aquifer recharge areas, tree removal, sediment and erosion control, and so forth. Ordinances of these types affect wildlife by protecting or regulating activities in open space areas of value to wildlife.

Some communities have expanded their ordinance packages to include broad coverage of environmental planning considerations, including wildlife. Such an example exists in Medford Township, New Jersey. A thorough environmental planning study was conducted there that identified the ecological parameters and developed an implementation program for preserving the environmental amenities of the community.

Gerald Haughey, a lawyer who worked closely with the environmental planning study, developed a 200-page legal report containing ordinances to implement the recommendations of the study. Basically, this document recommended that zoning be developed to regulate densities to provide for an ecologically sound community while maintaining the anticipated population growth. An integral component of the ordinance package required developers to prepare environental impact statements based on the original environmental study and to demonstrate that their project would ensure the retention of an ecologically viable community. This type of implementation procedure can help ensure the retention of viable wildlife habitats.

Other communities throughout the country are adopting ordinances requiring preparation of environmental impact statements for land development activities. Some are based on thorough environmental planning studies such as the one for Medford Township.[54] Others are not. Either approach can be used as an effective regulatory mechanism for ensuring the retention of wildlife amenities in developing communities.

Many states have taken the initiative to incorporate environmental impact statement requirements for land development activities. As of April 1976, 26 states had enacted such legislation.[55] Although not a regulatory control in the true sense, EISs have, perhaps, done more to ensure wildlife considerations on a project-by-project basis than any other mechanism.

The types of land development activities covered by these requirements vary among the states, as does the level of detail called for in the EIS itself. Some requirements are solely for specific types of activities, such as power plant siting. Others are more comprehensive and require impact statements for any type of land development of specified minimum acreage.

The permitting process is another form of regulatory mechanism that exists for the protection of fish and wildlife habitats. For example, federal involvement in public and private projects that have impact on fish and wildlife resources is mandated by Section 10 of the 1899 Rivers and Harbors Act and several sections of the 1972 amendments to the Federal Water Pollution Control Act (P.L. 92-500).

These laws reflect national recognition of the need to protect fish and wildlife resources from indiscriminate dredging and filling operations or from the discharge of substances that diminish or destroy the value of natural habitats. Regulations based on a permit system are administered by the Army Corps of Engineers and the U.S. Environmental Protection Agency.

The U.S. Fish and Wildlife Service participates in the permit-review system as a result of the Memorandum of Understanding between the Secretaries of the Interior and Army mandated by the Fish and Wildlife Coordination Act. The U.S. Fish and Wildlife Service has been involved mainly with permit applications relating to private and public dredge-and-fill projects in navigable waters.

In the future, the Service will become involved increasingly with other permit programs, such as the National Pollutant Discharge Elimination System (NPDES) Program under the 1972 amendments to P.L. 92-500. The past involvement by the Fish and Wildlife Service has resulted in denial or modification of many projects that otherwise would have been authorized.

Other sections of the 1972 amendments to P.L. 92-500, such as Sections 201, 208, 303E, are related more directly to the enhancement and protection of fish and other aquatic species than to terrestrial wildlife. These sections of P.L. 92-500 require studies to improve water quality conditions in receiving water bodies by analyzing pollution sources. Although typically these studies are conducted by consulting firms, municipal planners become actively involved since the studies determine future community wastewater planning programs. Municipal planners can use these studies as a source of significant information on planning related to fish and other aquatic species.

The studies conducted under Section 201 (Wastewater Facilities Planning Studies)—commonly referred to as 201 studies—are of greater utility for terrestrial wildlife planning efforts at the municipal level than those conducted under Sections 208 or 303E. The 201 studies are performed in greater detail because of the smaller study area and the greater site-specific wastewater planning considerations. The environmental assessment conducted as part of these studies to some extent evaluates the impact of alternative wastewater planning schemes on wildlife resources.

The location of wastewater facilities, particularly of interceptors, may help determine where and how much future growth will occur. Until the late 1960s and early 1970s, the location of highways was a key factor in directing areas of future growth. Since that time, with the highway construction program approaching completion, wastewater facilities have evolved as the major infrastructure stimulant for urban growth.[56] In using these

54. Narendra Juneja, *Medford: Performance Requirements for the Maintenance of Social Values Represented by the Natural Environment of Medford Township, New Jersey*, 1974, 64 pp. (Center for Ecological Research in Planning and Design, Department of Landscape Architecture and Regional Planning, University of Pennsylvania, Philadelphia, PA 19104.)

55. U.S. Council on Environmental Quality, *Environmental Quality. The Seventh Annual Report of the Council on Environmental Quality*, 1976, 378 pp. (U.S. Government Printing Office, Washington, DC 20402.)

56. Thomas Dolan IV and Robert M. Maestro, "The Environmental Assessment Statement as a Natural Resource Planning Tool," pp. 347-358 in *Transactions of the Fortieth North American Wildlife and Natural Resources Conference*, 1975. (Wildlife Management Institute, 1000 Vermont Ave., N.W., Washington, DC 20005.)

studies, planners can make sure that interceptors are located where the growth they stimulate will not destroy or impair valuable habitats.

Public acquisition is the most assured way to keep land open. Many variations of the "fee simple" process exist. Most planners are familiar with the transferable development rights approach being tried in several parts of the country. Although problems do exist in implementing a program of this type, the potential for open space retention and, therefore, wildlife habitat preservation does exist. This approach is being utilized in Hawaii; West Virginia; California; Suffolk County, New York; and other areas.

The purchase of open space or conservation easements also has been investigated in many areas. Arrangements have been made with some landowners to donate open space easements to the municipality. The donation of an easement as a gift provides benefits to the landowner through reducing assessment evaluation on his property as well as reducing federal income tax payment.

Conservation easements can be obtained in many ways: appropriations from general funds; special easements involving the determination of special benefits to abutting owners and the levy of assessments commensurate therewith; specific authorization for financing out of appropriations made to other public improvement programs for parks, recreation, highways, housing, urban renewal, or airport development; installment plan financing; revolving funds depleted and restored over a succession of years; excess condemnation for limited purposes; revenue bond financing; and through the participation of federal agencies.[57]

Another approach to the retention of open space areas is to use a severance tax by which the owner pays a reduced tax rate as long as he keeps his property in open space. However, if he ever wishes to develop the land commercially, he must pay the accumulated differential between the reduced tax rate and the full tax rate.[58]

Some states have programs that provide for the acquisition of land to be retained in open space. For example, the 1972 Environmental Quality Bond Act of New York State provided up to $175 million for acquisition and preservation of valuable land, including unique areas, wetlands, parklands, and open space in urban locations. The same program provided $4.5 million to acquire unique areas in the Hudson Valley and metropolitan areas of New York City and Long Island, $40 million for metropolitan parks, and $15 million for open space within city and suburban areas. Other states, such as Iowa, are setting up conservation districts with power to levy taxes to acquire land for wildlife reserves and parks.

The Nature Conservancy also purchases limited or unique open space parcels. Its activities in past years have provided for the retention of many valuable areas that otherwise would have been developed.

Additional guidance on the acquisition, conservation, design, creation, and preservation of open space areas can be obtained from several private and governmental sources.[59]

An increased awareness of wildlife considerations by planners along with an increased desire to incorporate wildlife amenities into planning should help significantly to maintain our wildlife heritage.

57. William H. Whyte, *The Last Landscape* (New York: Doubleday and Co., 1968), 376 pp.

58. Whyte, *The Last Landscape.*

59. Joseph J. Shomon, *Open Land for Urban America: Acquisition, Safekeeping, and Use* (Baltimore: Johns Hopkins University Press, 1971);

Ann Louise Strong, *Open Space for Urban America.* Prepared for the U.S. Department of Housing and Urban Development, 1965. 154 pp. (U.S. Government Printing Office, Washington, DC 20402);

Mildred F. Schmertz, ed., *Open Space for People: Acquisition, Conservation, Creation, and Design,* 1975. 111 pp. (American Institute of Architects, 1735 New York Ave., N.W., Washington, DC 20006);

Allison Dunham, *Preservation of Open Space Areas: A Study of the Non-Governmental Role,* 1966. 101 pp. (Welfare Council of Metropolitan Chicago, 64 E. Jackson Blvd., Chicago, IL 60604.)

Chapter 6. Planning for Wildlife in Developed Areas

Planning for wildlife in existing developed areas differs significantly from planning for wildlife in developing areas. Broad flexibility at the planning stage no longer exists. But, despite the generally unfavorable conditions for wildlife in urban areas, wildlife does exist in developed areas, and there is a place for it.

Trees along city streets die; old buildings, or sometimes large areas, are torn down and replaced; new urban parkways or city transit systems are developed. A burned-out building is razed, and the lot stands idle. These changing situations offer numerous possibilities for giving special consideration to wildlife values.

Wildlife in the central city need not be thought of solely as pigeons, starlings, house sparrows, rats, and mice. It can include American kestrels (sparrow hawks); nighthawks that nest on the flat roofs of city buildings; chimney swifts, which occupy tall chimneys; bats, which dart through the air at dusk in pursuit of insects; and resident or migrant songbirds in small parks and other vegetated areas.

The reptiles found in not too barren vacant lots and the butterflies that frequent flowering plants along parkways can be considered wildlife also.

Some of the guidance provided in chapters 4 and 5 applies to existing urban and suburban areas. Hence, in this chapter we shall focus on components of the urban and suburban framework through which additional benefits to wildlife can be achieved.

LANDSCAPING AND URBAN DESIGN

Although the small amount of urban open space typically available is a major limiting factor for wildlife, several suggestions have been advanced for making better use of it, including, where possible:

- closing off little-used streets;
- organizing parking; for example, using diagonal rather than parallel parking and providing second-story decks to be planted for open space;
- turning alley junkyards into center-block paths linking neighborhood to neighborhood;
- developing rooftop gardens;
- grouping fragmented private backyards into neighborhood recreational areas open to all;
- developing more intensive use of existing parks;
- adapting school grounds and school facilities to wider functions;
- rehabilitating empty lots as vest-pocket parks and linking them with larger, more comprehensively designed spaces in the city; and
- encouraging the use of backyards as open space.[60]

The main advantage to wildlife in changes like these is that additional vegetation becomes available, even if some of the trees and shrubs are in containers or plants are in hanging baskets. The wildlife that is attracted is sure to be noted and appreciated by some.

In designing for wildlife, once a reasonably continuous open space/wildlife corridor system has been developed, landscaping becomes the next most important consideration. Landscaping should be directed toward selecting plant species that both fit well into the urban environment and have food value for wildlife.

Plant Selection

Major consideration should be given to incorporating design elements that attract songbirds, since they represent a preferred species and are most adaptable to urban areas. The regional listings of plant species of value to wildlife in Appendix B should be referred to as a guide. Although these species are ranked relative to their overall value to wildlife in general, rating criteria is heavily weighted toward birds. Ratings specifically for songbirds are available.[61]

In tree replacement programs, especially in northern cities where deicing salts are used in large quantities, special consideration might well be given to selecting salt-tolerant trees. Mounding of planting areas would help prevent accumulation of excess salt in the root zone.

60. Paul M. Friedberg, "Projects for Urban Species," *Design Quarterly* 77, 1970, 32 pp., $1.60. (Walker Art Center, 807 Hennepin Ave., Minneapolis, MN 55403.) Friedberg describes some interesting examples of how open space areas were created through improved parking and traffic control and parks were developed in the space saved.

61. Martin, Zim, and Nelson, *American Wildlife and Plants;* Terres, *Songbirds in Your Garden;* Davison, *Attracting Birds.*

Snow fences, including living fences of shrubs, and, in the case of newly constructed highways, certain changes in engineering could reduce the problem of salt drift and salty runoff. Also, consideration might be given to placing the trees farther back from the street.

Much research is being done on the selection of trees for metropolitan environments and on the use of new cultivars to withstand the stresses of such environments.[62]

Assistance and advice from wildlife biologists should be sought in selecting trees and shrubs of most value to wildlife when other requirements for species selection are being considered. See Appendix B for general guidance on this subject.

In tree removal and tree pruning or cleanup operations, it should be remembered that a dead or hollow tree or a tree with a dead top or limb is useful to many wildlife species as a source of food, a place to den, or a perch. When such trees are located where they do not constitute a hazard to humans, consideration should be given to letting them stand. Likewise, in open space areas or parks, it should be noted that rotting logs are valuable to such species as salamanders and a host of invertebrate animals.

Landscaping

Landscaping efforts for wildlife in urban areas should continue beyond the selection of plant species. The design element is important also. As indicated elsewhere, vegetation groupings should provide for a multilayered effect instead of tall trees with woodchip understory.

Many additional types of songbirds, such as the wood thrush and the catbird, can be encouraged if an understory of small trees and shrubs is available. Incorporation of plantings to increase the edge effect provides additional benefits to songbirds.

Inasmuch as the broad expanses of reflective glass in office buildings have caused bird mortality, landscape architects should know that the danger to flying birds can be decreased if trees and shrubbery are so positioned that there is minimum reflection of the vegetation.

Where space permits, consideration may be given in the planning design to the possible development of community gardens. Although some crop protection or animal control measures may be needed, enough crop wastes and weed seeds usually remain after the harvest to be attractive to many forms of wildlife.

Urban Soils

An additional concern with respect to plantings in urban areas is the soil.[63] Soils in urban areas can easily become a limiting factor for establishment of plantings intended to benefit wildlife. Because of prior construction, urban soils may no longer be capable of supporting growth of healthy trees.

Frequently, topsoil is eliminated completely or mixed with subsoil. Bricks, asphalt, concrete, wood, and other construction materials make up various percentages of the soil. Often the soil is greatly compacted from construction activities, and this severely restricts the air available to root systems and makes the soil drain poorly.

All of these modifications produce a substrate deficient in nutrients and the physical characteristics necessary for successful and healthy growth of plants. Therefore, although wildlife considerations may have played a part in the selection and arrangement of plant species, all efforts may be to no avail if the soil will not support vegetation.

Soil reconditioning can be achieved in different ways. One way is to remove some of the modified substrate and replace it with topsoil. This is the most expensive method. Other approaches include adding sewage sludge and/or woodchips.

Regardless of the type of original material or the reconstruction practices, the soil should be tested to determine chemical characteristics that may influence the type of species suitable for planting and the fertilizers that may be required.[64]

Fertilizers and Insecticides

With respect to the maintenance of vegetation, concern has been expressed about the excessive use of fertilizers and insecticides. The use of a mixture of native species of plants that are less subject to disastrous die-offs and the possibility of biological control also have been mentioned.

64. Patterson, *Planting in Urban Soils.*

Opportunities for nature study exist even in highly urbanized areas, as the children exploring these vacant lots demonstrate.

62. F. S. Santamour, Jr., H. D. Gerhold, and Silas Little, eds., *Better Trees for Metropolitan Landscapes,* Technical Report NE-22, 1976, 256 pp. (Northeastern Forest Experiment Station, U.S. Forest Service, 6816 Market St., Upper Darby, PA 19082.) See especially the article, "Salts and Woody-Plant Interactions in the Urban Environment," by Michael A. Dirr, pp. 103-111.

63. James C. Patterson, *Planting in Urban Soils,* Ecological Services Bulletin No. 1., 1974, 23 pp. (U.S. National Park Service, Washington, DC 20240.)

REDEVELOPMENT PROJECTS

Maximum benefits can be derived for wildlife in major redevelopment projects through landscaping and the development of an open space plan. Because undisturbed land and water is limited in cities, sensitive planting and design are critical. Typically, any relatively large open space is planned for heavy public use and has little resemblance to a natural area. Because of various stress factors, including poor soils, pollution, and heavy usage, greater care will be needed in selecting, planting, and caring for trees and shrubs.

The first consideration should be the relationship of any planned open space to the surrounding area. As with site planning in developing areas, all efforts should be made to provide an open space/wildlife corridor system that connects with adjacent open space areas. Adjacent land uses should be analyzed to define potential open space links.

The best available connecting link may be a nearby residential area with small adjoining backyards, a parkway, or a railroad right-of-way. Species typical of urban areas—for example, songbirds and squirrels—do not need very wide corridors, and even small ones are better than none at all.

In rehabilitation projects, however, it is suggested that as many of the trees as possible be in natural situations to reduce maintenance costs.

PARK PLANNING AND MAINTENANCE

In planning for the maintenance or renovation of city parks, planners should try to maintain diversity of vegetation and preserve natural streams, tributaries, and wetland areas. In existing parks, planting of trees and shrubs can help diversify habitats and thereby increase wildlife diversity.

In downtown parks, the shrub plantings are especially important. Shrubbery and understory vegetation are essential for substantial songbird populations. Most songbirds (mockingbirds, brown thrushes, towhees, song sparrows, and so forth) require shrubs or understory vegetation for nesting and escape shelter.[65] As a means of enhancing and maintaining natural diversity, the use of imported plant species in landscaping should be deemphasized in favor of native plant species.

Security must be considered in downtown parks and heavily populated areas. In such cases, dense shrub plantings near walkways should be avoided.

Most urban parks lack weed seeds, which are extremely valuable to wildlife. Seed can be provided by planting annual food plots (for example, sorghum and millet) in an aesthetically appealing fashion. Many of these annual "crops" are attractive and, through proper landscaping, can be accommodated easily in the urban park.

Natural meadows for field-dependent animals can be provided in selected areas by reducing the frequency of mowing to once in late summer. In this way, woody

vegetation can be controlled after the peak nesting season is over.

In large new developments or redevelopment projects, the planner should require an inventory of the plant and animal species present on the entire site and strive to preserve as parks those areas with the greatest ecological and taxonomic diversity. People should be encouraged to accept a more natural and species-rich concept of a park.[66]

It may be desirable to incorporate nature trails to promote conservation education and the enjoyment of nature by residents or visitors to the area. Knowledgeable persons should be invited to go over the area to help identify interesting features and help lay out the trails. The assistance of such people later would ensure the use of more interesting and factual information in signs, labels, and interpretive leaflets.

Good advice on how to develop nature trails is available.[67] In the interest of wildlife conservation, a trail system should permit access with minimum impact on ground-level plants and animals. This may require elevated boardwalks over wet areas.

ARCHITECTURAL CONSIDERATIONS

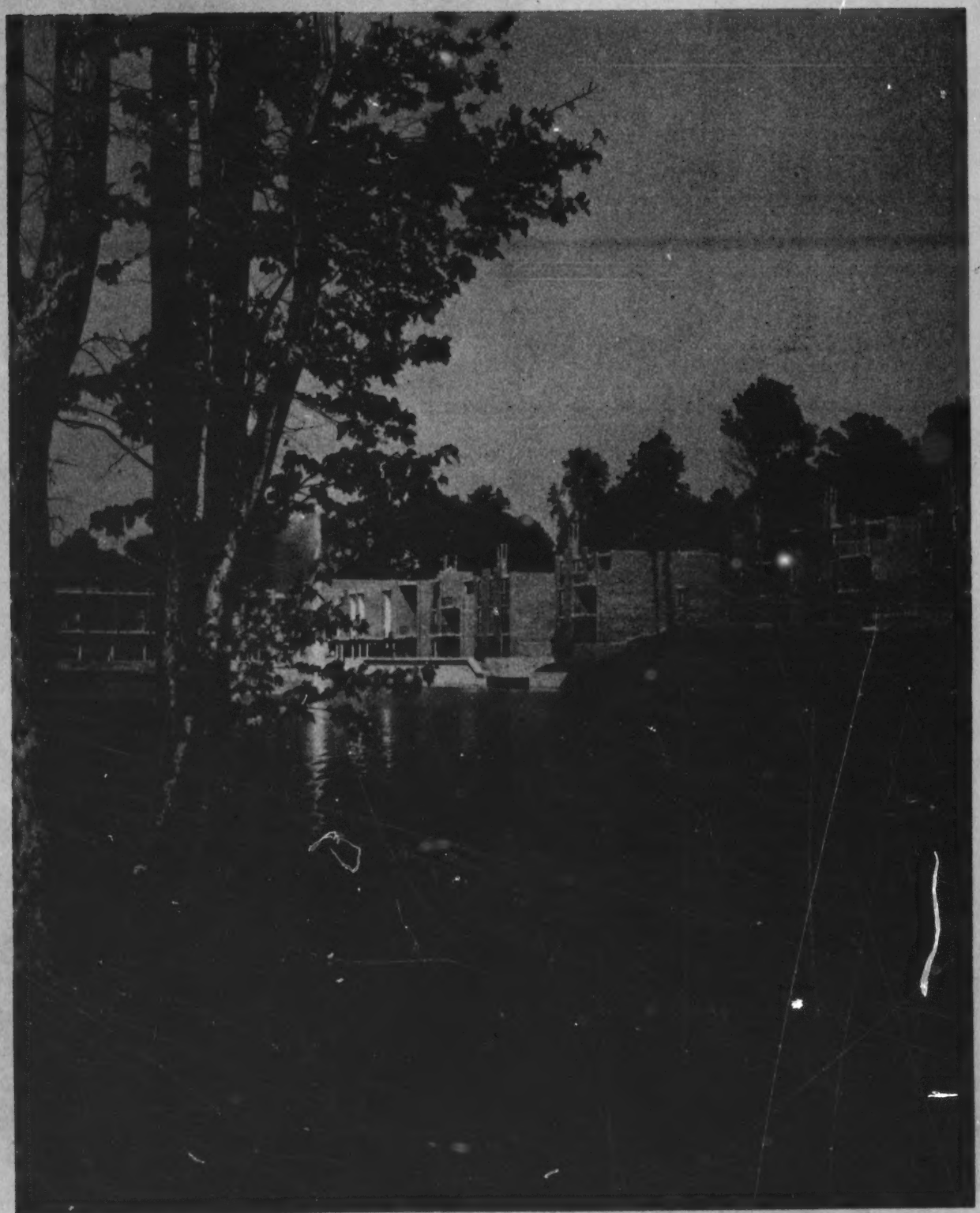
As any urban resident or visitor is aware, the wildlife of many urban areas consists primarily of nuisance birds such as pigeons, starlings, and house sparrows. Their predominance in urban areas is due to architectural design, poor building quality, and the lack of sufficient open space vegetation for other species. Attempts should be made to compensate for these factors in the planning and design of urban renewal projects.

Architectural considerations have been treated in chapter 4. Although city inner-core structures differ somewhat from those in residential areas, the principles discussed are appropriate to both.

65. Eugene P. Odum, "Ecological Principles and the Urban Forest," pp. 78-81 in *Proceedings, Symposium on Role of Trees in the South's Urban Environment*, 1971. (Center for Continuing Education, University of Georgia, Athens, GA 30602.)

66. Howard W. Campbell, "The Problem of the Preservation of Geographic Variability"; Paper given at the American Society of Zoologists Symposium: Toward a System of National Ecological Preserves, Houston, Texas, December 27, 1973, 11 pp.

67. Charles E. Mohr, "Environmental Study Areas: Wildlife Preserves," *Audubon Nature Bulletin*, a part of set NB6-9, 1961, 6 pp. (National Audubon Society, 950 Third Ave., New York, NY 10022.)



Open space preservation was a primary concern in the planning of Reston, Virginia. Lake Anne Village, one of its seven planned communities, is built around a 32-acre spring-fed lake.

Chapter 7. Special Wildlife Planning and Design Concerns

There are certain components of the urban environment that have a bearing on wildlife and are of concern to planners and developers whether dealing with urban redevelopment or urbanizing areas. These features or requirements, common to both types of areas, include: water supply and facilities for managing water; means of disposing of wastes; vegetation management; and transportation facilities, including mass transit, streets and highways, and airports.

The discussion of these features that follows is applicable to both larger-scale planning and site design.

WATER AND WATER MANAGEMENT

Water in some form is essential to all life and is the medium or environment in which a great many species of plants and animals exist. The way in which water is managed affects species greatly.

Thus, the drainage or filling of a marsh in the process of urbanization will destroy wetland habitat; the creation of a pond or lake in an open space area will provide a new habitat. Controlling the water level in an impoundment will control the type and quantity of vegetation along the shores. The accelerated erosion caused by construction activities or the pollution stemming from industrial plants or improper sewage disposal can so degrade the water that it is not productive of desirable animal life.

It is well known that lack of domestic water and sewage facilities can limit urban development, but not so well recognized is the fact that the manner in which wastes—both solid and liquid—and storm drainage are handled can affect fish and wildlife.

Urbanization, as we have noted, has resulted in the elimination of many free-flowing streams and tributaries, the pollution of larger streams and lakes, and the drainage or filling of both coastal and inland wetlands. In planning for urban renewal or for new development, such destruction and degradation of aquatic habitat should be avoided to the extent possible.

Streams

Each year more than a million acres of land in the United States are converted from agricultural to urban use.[68] In the process, especially in the conversion of wooded areas into cities, many streams become covered or channelized storm sewers, and many wetland areas are drained or filled. This has serious impact on aquatic life and on such species as amphibians and reptiles, waterfowl, raccoons, and many other kinds of birds and mammals.

With respect to urban wildlife planning and management, three principles should be observed: (1) preserve existing high-quality streams and other water bodies; (2) improve those that need improving; and (3) create additional impoundments or wetland areas.

Some of the existing streams, lakes, and wetlands can be preserved by incorporating them into open space areas or through proper land use and erosion or pollution control measures. Elimination of water pollution and retention of natural features are beneficial to wildlife. For example, the increasing demand for water in urban areas necessitates that municipal watersheds be managed to increase water production and improve water quality.

The building of access roads to these areas affects both water quality and wildlife. Roads should be located as far from streams as possible because of habitat disturbance and accelerated erosion. Buffer strips are helpful in preventing erosion, preserving the stream channel's integrity, maintaining suitable water temperatures for aquatic life, and providing insects as food for birds, fish, and other wildlife.[69]

It has been suggested that on watersheds filter strips bordering tributaries in flat terrain should be 50 feet wide with an increase of four feet for each one per cent of slope.[70] This guideline may be useful in determining the width of vegetation desirable for erosion control along streams in other urban open space areas. Even narrower vegetative strips have value for wildlife, however.

Improvement of degraded streams and other water bodies may require the reduction of siltation and pollution and the control of other activities that affect the carrying capacity of aquatic environments for wildlife. Some control over the diversion or consumptive use of water may

68. Soil Conservation Service, U.S. Department of Agriculture, *Controlling Erosion on Construction Sites*, Agriculture Information Bulletin 347, 1970, 32 pp. (U.S. Government Printing Office, Washington, DC 20402.)

69. Robert L. Curtis and Thomas H. Ripley, "Water Management Practices and Their Effect on Nongame Bird Habitat Values in a Deciduous Forest Community," pp. 128–141 in *Proceedings of a Symposium of Management of Forest and Range Habitats for Nongame Birds*, General Technical Report WO–1, 1975. (U.S. Forest Service, Washington, DC 20250.)

70. G. R. Trimble and R. S. Sartz, "How Far from a Stream Should a Logging Road Be Located?" *Journal of Forestry* (May 1957), pp. 339–341.

be necessary to support certain animal species. In the case of streams and tributaries converted into enclosed storm sewers, there is little that can be done to remedy conditions for fish and wildlife.

In the case of the stream channelization needed for road construction or other aspects of urbanization, remedial measures are possible. Channelized portions of a river can, with the installation of in-stream rehabilitation structures such as deflectors and check dams, be developed so that the hydrologic features resemble unchannelized streams and the conditions for aquatic life are similar to unchannelized streams. Channelized streams can be improved, also, by stream-bank plantings of willows and other vegetation, by creation of spawning beds, and by putting brushy or other types of cover in them.

Information on the needs of fish and other aquatic organisms can be obtained from the U.S. Fish and Wildlife Service and the respective state fish and game departments. Much practical how-to information on planning and management for stream improvement is contained in the U.S. Forest Service's *Wildlife Habitat Improvement Handbook*.[72]

Impoundments

Many urban areas depend, at least in part, on lakes or reservoirs for their water supply. Some of these are used also for fishing and other forms of water-based recreation. Planners may wish to include in their planning design provisions for recreation or multipurpose improvement.

Properly designed impoundments can enhance fish and wildlife by increasing habitat diversity. Such improvements provide recreation and aesthetic benefits and increase real estate values.

Useful information and criteria for designing and constructing impoundments, such as multipurpose reservoirs, ponds, and stormwater detention basins, are available from the Urban Land Institute.[73] Other sources of advice and assistance are the U.S. Soil Conservation Service, the U.S. Fish and Wildlife Service, and the U.S. Geological Survey.

Professionals should be consulted in the construction of any of these impoundments. In contacts with these professionals, planners should specify clearly their interest in fish production and wildlife enhancement or a combination of these.

Fishponds are of two types: warm-water ponds, which support populations of bass, bluegills, and catfish; and cold-water ponds, which are best suited to trout.

Cold-water ponds have a temperature of not more than 70°F. when measured six inches below the surface on a summer morning before sunrise. Figure 5 shows the geographical areas best suited to trout ponds. Cold-water ponds may be constructed elsewhere if fed by cold springs.

FIGURE 5. AREAS WHERE TROUT PONDS ARE MOST SUCCESSFUL

Warm-water ponds are those that exceed 70° F. when measured as described above.

The planner should be aware that many other factors can affect the productivity of a pond. Temperature, oxygen content, pH, nutrient content, siltation, seepage, evaporation, and various forms of pollution must be considered. For further information relative to the construction and management of fish ponds, the Pennsylvania State University publication entitled *Fish Ponds: Construction and Management in Pennsylvania* is helpful.[74]

Fishponds typically are designed with steep banks to discourage the growth of aquatic vegetation. A depth of three feet around the margin of the pond discourages plant growth.

Impoundments designed to attract a broad variety of wildlife including waterfowl, wading birds, and a variety of reptiles and amphibians should have gently sloping margins of less than three feet in depth to encourage growth of aquatic vegetation.

The wildlife impoundment should include a positive water control structure that will permit the raising and lowering of water levels. This capacity is desirable for both fish and wildlife management purposes. For example, fish populations can be controlled by lowering water levels to restrict access to nesting sites. On the other hand, wading birds or shorebirds will be attracted to areas where fluctuating water levels frequently expose areas of mud and silt and shallow water.

Multipurpose fish and wildlife ponds can be created by designing ponds with shallow margins and deep water in the interior.

If the planner is concerned with excessive growth of vegetation around the margins of wildlife ponds, he should consider designing a multipurpose pond in the

71. J. R. Barton and P. V. Winger, *Rehabilitation of a Channelized River in Utah: Hydraulic Engineering and the Environment, Proceedings of the Hydraulic Speciality Conference* (Bozeman, Montana: Montana State University, 1973), pp. 1–10.

72. *Wildlife Habitat Improvement Handbook*, 1969. (U.S. Forest Service, Washington, DC 20250.)

73. Joachim Tourbier and Richard Westmacott, *Lakes and Ponds*, Technical Bulletin 72, 1976, 73 pp. (Urban Land Institute, 1200 18th St., N.W., Washington, DC 20036.)

74. T. D. Rader, R. G. Wingard, and C. L. Heiney, *Fish Ponds: Construction and Management in Pennsylvania*, Special Circular 216, Natural Resources Series, undated, 19 pp., prepared in cooperation with the U.S. Soil Conservation Service. (Cooperative Extension Service, Pennsylvania State University, University Park, PA 16802.)

following manner. The pond margins should have 3:1 slope to a depth of three feet. At this point the bottom should become level or gently sloping for a distance of several feet. The bottom can then slope gradually to 15 feet at the center of the impoundment. Using a proper water control structure, water level may then be raised or lowered to flood or expose the flat area for management purposes.

Storm detention ponds and catchment basins should be installed prior to the initial grading of the development site in order to trap the large quantities of sediment generated by construction. Also, provision should be made for easy removal of the sediment. The design should be such as to minimize possible washouts and damage to property, hazards to children who play in the area, and harm to the multiple uses to which the larger ponds can be put. Well-vegetated, gently sloping banks and shallow margins are not only safer for children but lend themselves to the production of aquatic plants valuable to wildlife.

If possible, detention and sediment ponds should be retained after housing construction is completed, to provide the valuable wetland habitat so often lacking in urban areas. Water control structures and emergency spillways should be designed as permanent structures meeting local ordinances to ensure the preservation of the ponds.

In Columbia, Maryland, the value of sediment ponds to wildlife has been clearly demonstrated. When housing construction was completed, some citizens pressed for the removal of these ponds. However, removal was delayed, and the ponds developed into excellent wetland habitat with attractive plant and animal life. Residents now enjoy these natural areas and have worked for their preservation. As a result, many of the sediment ponds have been retained and some redesigned as permanent structures.

Sand and gravel pits and stone quarries are common features of urban areas and, after extraction of the materials, may be used for many purposes, including flood-water storage and desilting basins, recreation lakes, and fish and wildlife enhancement. Mined areas need not be used only for fish production or waterfowl. The wet pits or ponds left after mining may constitute only a portion of the area; the rest of the area, with proper revegetation and management, can be valuable for songbirds and other wildlife species.

Removing stop logs on the water control structure of a multipurpose fish and wildlife pond.

By preplanning, consultation with biologists, and progressive rehabilitation and revegetation, problems of erosion and siltation can be minimized. In such cases, topsoil can be removed and steps taken to revegetate as the sand and gravel mining goes along.

If the wet pits or lakes are intended for fish production, the biologist may recommend steep slopes and deep water. If the empahsis is to be on waterfowl or shorebirds, considerable shallow water and broader beaches would be valuable. For ducks and geese, the planting of fields of corn and green wheat on the adjacent uplands for food and the construction of islands within the lake for loafing and nesting will increase the carrying capacity of the area. Methods of progressive rehabilitation of mined areas have been well described.[75]

Estuarine Areas

Development that takes place in coastal and estuarine areas can cause the degradation of exceptionally valuable

75. Anthony M. Bauer, *Simultaneous Excavation and Rehabilitation of Sand and Gravel Sites: A General Survey and Analysis of Preoperational Factors and Procedures*, 1965, 60 pp.; Craig Johnson, *Practical Operating Procedures for Progressive Rehabilitation of Sand and Gravel Sites*, 1966, 75 pp. University of Illinois and National Sand and Gravel Association. (Available from National Sand and Gravel Association, 900 Spring St., Silver Spring, MD 20910.)

FIGURE 6. MULTIPURPOSE POND
Water level can be controlled by raising or lowering a gate at the outlet.

Maximum feasible slope to 3' depth
Where there is a safety hazard, gently slope to 6' depth
Slope as desired to max. depth
Maximum depth as required
3'
6'
Minimum depth 15' in cold climates to prevent fish kill

and productive fish and wildlife habitats. This is especially true in finger-type developments that involve filling coastal marshes or dredging channels to enable residents to run a boat up to their homes. Such a development interferes with the natural circulation or flow of water and often results in heavy loads of silt and pollution.

On the basis of long-term studies of coastal ecosystems, the Conservation Foundation has formulated guidelines and recommendations that, if followed, would permit restricted development of parts of the estuarine zone without serious disruption of the ecosystem.[76] Adhering to these criteria for development would avoid interference with the ebb and flow of the tide and activities that would alter the most sensitive parts of the ecosystem.

The lake around which this subdivision was built was created by damming a ravine in an outlying wooded and pastureland area.

Stormwater Control: Physical Aspects

Channel improvements—such as realignment of the stream course, use of concrete channels, dredging, clearing of vegetation, and excessive use of culverts to accommodate the rapid runoff from urban areas—eliminate important aquatic habitat. Although, as indicated previously, some rehabilitation can be accomplished through installation of deflectors and low dams and revegetation of the stream banks, stream channelization should be kept to a minimum.

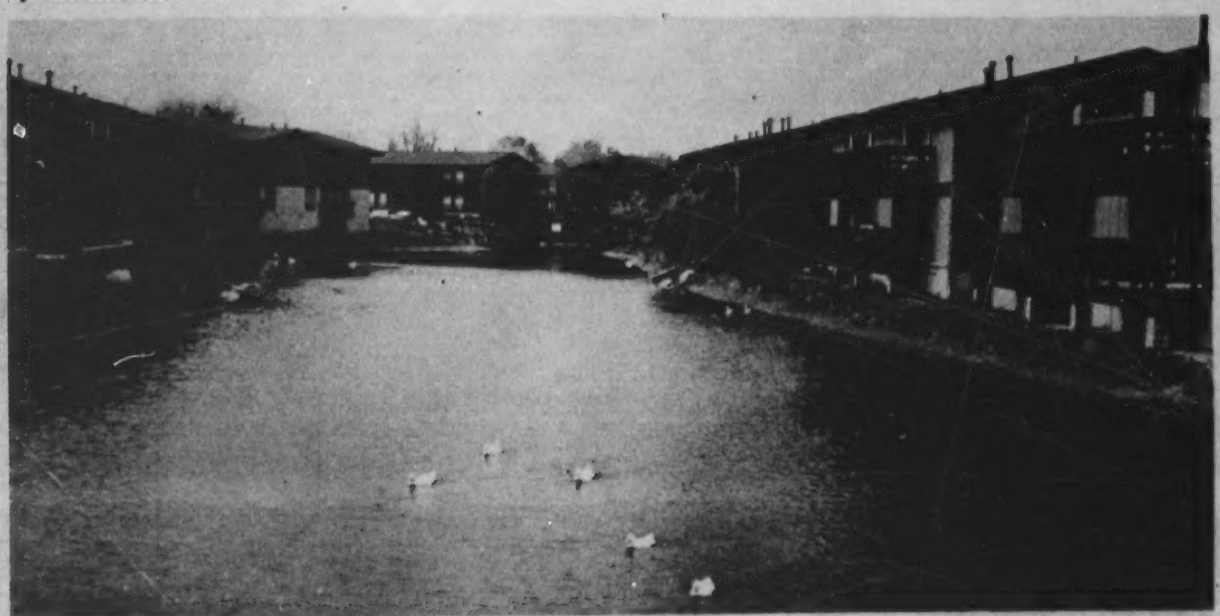
Planners and engineers are beginning to recognize the value of using natural drainage systems as much as possible. It has been demonstrated that some natural channels can accommodate more runoff during extreme storms than artificial storm drainage.[77] Oxbow lakes, overflow ponds, and wet areas along streams often are highly productive of fish and wildlife. Adequate flood control on a regional basis is related to good land use.

When structural control of flooding is necessary, there is still opportunity to incorporate provisions for aesthetic enhancement in the plans. In San Antonio, Texas, for example, a very successful "river walk" was developed in conjunction with a comprehensive flood control plan for the San Antonio River, which flows through the city. The

76. John Clark, *Rookery Bay: Ecological Constraints on Coastal Development*, 1974, 91 pp. (Conservation Foundation, 1717 Massachusetts Ave., N.W., Washington, DC 20036.) This is a summary report indicating how information on hydrology, biology, land use, and socioeconomics can be presented and used in the decision-making process and implemented through enactment of local ordinances. It is supplemented by 10 background study reports, also available from the Conservation Foundation.

77. David A. Rickert and Andrew M. Spieker, *Real-Estate Lakes: Water in the Urban Environment*, Circular 601-G, 1971, 19 pp. (U.S. Geological Survey, Reston, VA 22092.)

All stormwater from this development is collected in the pond and then released gradually. The excavated material was used to raise the level of the apartment area.



river walk has emerged as an aesthetically unified area, due to the integration and sensitivity of engineering, architectural, and landscape design. Tourism generates almost $100 million annually for the city, and over four million visits are made to the river walk each year.[78]

On- and off-site retention ponds not only can serve their flood protection purposes but, with care in their design, can be attractive to waterfowl and other wildlife.

A report by the American Public Works Association contains a review of methods of on-site detention of water as well as useful suggestions for implementing various types of stormwater management plans and programs.[79]

Stormwater and Wastewaster Control: Pollution Aspects

Urban water bodies and riverine habitats in or downstream from cities are affected by various types of pollution that in turn affect fish and aquatic organisms. For example, a recreation or multipurpose lake in an urban community can recycle some of man's wastes, but the load resulting from septic tank seepage or discharge from a sewage treatment plant frequently results in eutrophication or overenrichment of the lake waters. This, in turn, may result in excessive algae and weed growth sufficient to interfere with boating and fishing and create unpleasant odors when the plants die and decompose.

The organic compounds in the effluent of septic tanks or sewage disposal plants impose a biochemical or biological oxygen demand (BOD) on the receiving body of water, thereby decreasing the amount of dissolved oxygen (DO) available to aquatic organisms. Unless there is adequate treatment, the addition of sewage effluent reduces DO levels below acceptable limits for trout and other high-oxygen-demanding species for appreciable distances downstream.

Similarly, urban streets may contain contaminants that are quite toxic—especially from automobiles and insecticides from lawns. When these enter streams at the peak of a storm, they may cause serious damage to wildlife.

One study showed that the quantity of contaminant material averaged on the order of 1,400 pounds per curb mile for the cities tested.[80]

Motor vehicle traffic is responsible for deposition of substantial quantities of materials on roadways, including significant levels of toxic heavy metals, asbestos, and slowly biodegradable petroleum products and rubber. Runoff from urban roadways induces shock effect upon receiving waters and the biota of these waters as the accumulated nutrients and toxic and oxygen-demanding substances are introduced abruptly during a storm.

An EPA study mentions the following possibilities for reducing these shock loads:

- select roadway sites so as to minimize the area draining directly into the receiving body of water;
- utilize low curbs where the road is adjacent to flat, unpaved areas or areas that slope gently away from the street surface. This will facilitate the deposition of the dust and dirt into grass and gravel areas and reduce the rate of deposition in runoff water;
- consider the use of porous pavement in areas where climate and soil types will permit it;
- intensify and improve street-cleaning operations to reduce urban roadway runoff effects;
- design curbs and gutters to facilitate concentration and collection of particulate material; and
- investigate various approaches to detention and storage of storm runoff and separation of solids from stormwater.[81]

Treatment or preventive measures are being developed under Section 208 of the Clean Water Act (P.L. 92-500) to clean up waterways.

SEDIMENT AND EROSION CONTROL

Sedimentation has significant impact on fish and other aquatic species.

Each year, more than a million acres of land in the United States are converted from agricultural to urban use. In addition to the loss of good wildlife habitat directly through the replacement of vegetation with buildings and pavement, urbanization causes accelerated erosion and sedimentation in lakes and streams with consequent degradation of aquatic habitat.

Studies have shown that erosion from construction of highways, houses, or shopping centers is about 10 times greater than the erosion of land in cultivated row crops; 200 times greater than land in pasture; and 2,000 times greater than land in timber.[82]

The USDA Soil Conservation Service says that erosion and sedimentation can be controlled, and at reasonable cost, if certain principles are followed in the use and treatment of land. These principles are: (1) using soils that are suited for development; (2) leaving the soil bare for the shortest time possible; (3) reducing the velocity and controlling the flow of runoff; (4) detaining runoff on the site to trap sediment; and (5) releasing runoff safely to downstream areas.

Municipal planners can greatly benefit the aquatic wildlife resources within their areas of jurisdiction by incorporation and enforcement of sediment and erosion control regulations based on these principles. However, the Soil Conservation Service indicates that few local gov-

78. David J. Reed, "The San Antonio River Walk: A User and Environmental Analysis," *Journal of Soil and Water Conservation*, Vol. 31 (1976), pp. 28-30.

79. Herbert G. Poertner, *Practices in Detention of Urban Storm Water Runoff: An Investigation of Concepts, Techniques, Applications, Costs, Problems, Legislation, Legal Aspects, and Opinions*, Special Report No. 43, 1974, 231 pp. (American Public Works Association, 1313 E. 60th St., Chicago, IL 60637.)

80. James D. Sartor and Gail B. Boyd, *Water Pollution Aspects of Street Surface Contaminants*, EPA-R2-72-081, U.S. Environmental Protection Agency, 1972, 236 pp. (U.S. Government Printing Office, Washington, DC 20402.)

81. Donald G. Shaheen, *Contributions of Urban Roadway to Water Pollution*, Environmental Protection Technology Series, EPA-600/2-75-004, 1975, 228 pp. (U.S. Environmental Protection Agency, Washington, DC 20460.)

82. Soil Conservation Service, U.S. Department of Agriculture, *Controlling Erosion on Construction Sites*.

Uncontrolled erosion such as this, caused by the removal of the natural vegetation, can have disastrous effects downstream also.

ernments have adopted either erosion and sediment control programs or the appropriate ordinances, building codes, and regulations to help carry out their conservation policies. Ordinances sometimes have failed to accomplish their intended purpose because they were too complicated and vague.

Those that seem to work tie certain controls into the local code by adding to or amending existing subdivision regulations. Builders and developers already complying with the code merely assume additional responsibilities.

A particular aspect of such ordinances that affect wildlife is the requirements for revegetation for erosion prevention. Some indication of the value of various plants to wildlife is given in Appendix B. Use of native grasses, trees, and shrubs would be more desirable for wildlife generally and would require less maintenance than some of the other species used. For example, although Kentucky 31 fescue grass grows well and can withstand much foot traffic, it tends to retard the invasion of plants more valuable to wildlife.

Red alder trees saved from destruction. Ground cover and fallen trees also were allowed to remain.

OPEN SPACE AND VEGETATION MANAGEMENT

Although considerable attention has been given in this manual to the planning of open space areas for wildlife, additional discussion may be warranted on approaches to implementation in areas already established, such as parkways, cemeteries, institutional grounds, and golf courses. Wildlife amenities on any area can be greatly enhanced through open space management approaches that combine the needs of people with those of wildlife.

Open Space Vegetation Management

For some existing open space areas, the best management may be to leave them alone and cause no disturbance of the land form, topsoil, surface water, or vegetation. For many designated open space areas, however, there are many things that can be done with the assistance of biologists and the support of the local public.

For example, inasmuch as vegetation is so important to wildlife, the manner in which vegetation is managed should be examined with the view to recommending changes that will be helpful to wildlife and acceptable to the people in the area.

To most urban and suburban dwellers, open space may be equated with lawnlike conditions involving frequent mowing and usually fertilization and reseeding. While this turf may be a home for ground moles or a source of earthworms for robins, it provides little attraction for most wildlife. Less frequent mowing of these grass-covered open areas and their designation for wildlife development will improve conditions for many kinds of wildlife and will, at the same time, reduce maintenance costs.

Cessation of mowing will, after a few years, result in the growth of woody vegetation in the course of plant succes-

sion. In deciding upon which portions of the area to manage for wildlife, consideration should be given to the development of cover that will link up with other tracts of cover, serve as wildlife corridors or travel lanes, and provide a maximum of edges. When the shrubs and trees reach the desired stage for wildlife purposes, the selective use of herbicides, mechanical brush-hogs, or cutting will help keep the vegetation at that stage.

Research and experiments in Connecticut have demonstrated that, through employment of ecologically sound techniques and selective application of herbicides, shrub communities with high stability and wildlife values can be established. Clones of huckleberry, greenbrier, low blueberry, witch hazel, speckled alder, sheep laurel, gray dogwood, and nannyberry, once established, have resisted tree invasion for many years.[83]

Shrubby growth can be maintained without mowing or blanket spraying of herbicides, which leave unsightly dead plant material.

Management of Old Fields

Old fields that are dominated by broom sedge or bunchgrass and other vegetation not particularly valuable for wildlife can be improved by disking. This stimulates the growth of annual plants that have more food value for seed-eating birds and other wildlife.

Depending upon the emphasis to be placed on wildlife, food plots containing corn or mixtures of annual lespedezas, millet, buckwheat, soybeans, cowpeas, milo, and rape can provide supplemental foods for wildlife. The foodplants should be established adjacent to good cover for most effective use.

83. W. A. Niering and R. H. Goodwin, "Creation of Relatively Stable Shrublands with Herbicides: Arresting 'Succession' on Rights-of-Way and Pastureland," *Ecology*, Vol. 55 (1974), pp. 784-795.

Islands in impoundments can serve as nesting sites for waterfowl.

Also, the judicious planting of shrubs and trees valuable to wildlife can increase the carrying capacity of open space areas. (See Appendix B.)

Parks

In some established parks, the understory vegetation has been removed and attempts have been made to establish grass. The lack of shrubs and saplings reduces the diversity of cover and, hence, the diversity of wildlife. While recognizing that muggings and assaults may be more frequent in those parks with dense woody cover close to streets or paths, park planners still may be able to encourage such cover in the more remote sections of the park for use by wildlife.

Likewise, in many parks, there is zealous removal of dead trees or of dead limbs of trees. Again, if some of these trees were left standing and if fallen trees or limbs were left to decompose, there would be decided benefits to wildlife.

Fields bordered by wild hedgerows that provide travel ways for wildlife.

Cemeteries

Cemeteries, often being of a parklike nature with many different kinds of trees and shrubs and other vegetation, are used by a variety of wildlife species and have long been visited by bird watchers. In Boston and its suburbs, biologists found that cemeteries constitute 35 per cent of the open space remaining in the area and that four of the 50 cemeteries had active wildlife management programs.[84] Since over half of the cemeteries are publicly owned and most allow public access, more wildlife management in such areas would seem possible.

Forest Lawn Cemetery in Buffalo, New York, has long been known as a bird sanctuary and publishes a booklet describing the birds to be found on its grounds. Other cemeteries distribute pamphlets describing their trees, plants, and wildlife.[85]

Institutional Grounds and Golf Courses

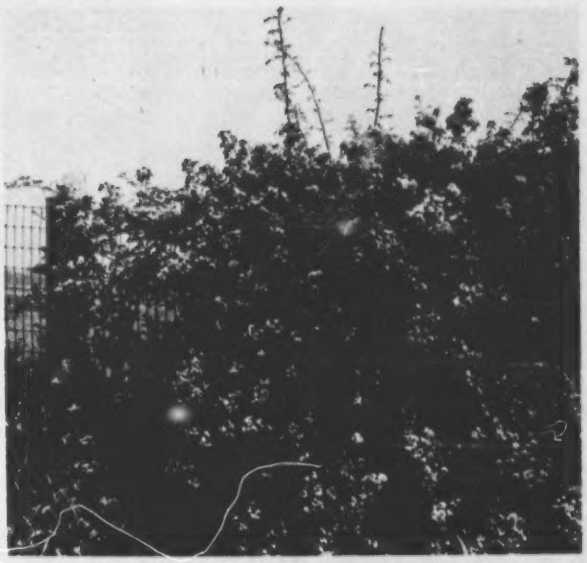
Institutional grounds and golf courses also offer wildlife management possibilities, particularly in the selection of plants for landscaping purposes and the distribution of the plantings. The landscape architect, in selecting plant species and designating where they should be planted, helps determine the wildlife carrying capacity of an area.

Some ecologists have observed that the trend on campuses and in urban landscaping stressing tall trees scattered in expanses of grass or low groundcover with a minimum of massed shrubbery—so characteristic of older campuses and residential districts—is unfavorable to songbirds. They point out that most songbirds require medium-height, dense cover for both nesting and escape cover and that the absence of an intermediate shrub layer between trees and groundcover drastically reduces the size and diversity of the songbird population. They suggest that, although massed shrubbery near or against buildings may hide the clean lines of the building design, clumps of shrubbery and small trees placed away from buildings can, in themselves, provide both attractive design and cover for birds.[86]

84. J. W. Thomas and R. A. Dixon, "Cemetery Ecology," pp. 107-110 in *Wildlife in an Urbanizing Environment.*

85. Earl Finkler, *The Multiple Use of Cemeteries*, Planning Advisory Service Report No. 285, 1975, 22 pp. (American Society of Planning Officials, 1313 E. 60th St., Chicago, IL 60637.)

The shrubs and fruit trees that remain as a farm gives way to development furnish cover for birds.



A hybrid rose trained on a fence provides wildlife habitat as well as screening.

Privately Owned Residences

In the case of privately owned detached residences, planners and developers set the stage for what the individual property owner has to work with when they lay out the lot and develop landscaping plans. The construction firm or builder also contributes to the condition of the lot by the degree of care taken to conserve the topsoil, prevent undue erosion, and disturb as little as possible the existing vegetation.

From that point on, what is done toward improving conditions for wildlife is largely up to the individual owners. What the owners do is important, however, because residential yards represent a substantial portion of the space available for wildlife in urban areas.

A detailed account of methods that can be used to encourage wildlife on private lots is not presented in this manual; but the same general approaches toward satisfying the food, water, cover, and space requirements of wildlife species that were discussed earlier apply to urban lots. Many leuflets and bulletins, particularly with respect to attracting birds, are available from such agencies and organizations as the U.S. Fish and Wildlife Service and the National Audubon Society, or from local Audubon societies. The National Wildlife Federation has publications dealing with backyard management measures, not only for birds but for other wildlife.[87]

86. Eugene P. Odum and Sharon Davis, "More Birds in the Bushes from Shrubs in the Plans," *Landscape Architecture*, October 1969, p. 36.

87. J. W. Thomas, R. O. Brush, and R. M. DeGraff, "Invite Wildlife to Your Backyard," *National Wildlife Magazine*, April-May 1973, pp. 5-16;

Gardening with Wildlife—A Complete Guide to Attracting and Enjoying the Fascinating Creatures in Your Backyard, 1974, 190 pp. (National Wildlife Federation, 1412 16th St., N.W., Washington, DC 20036.)

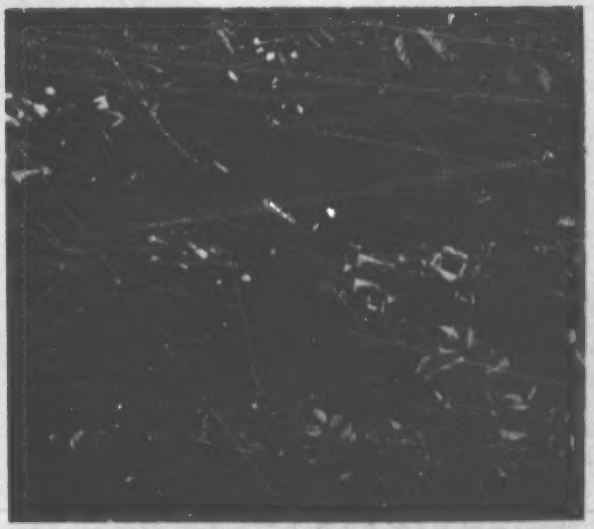
Other Sites

Often the sites selected for houses or buildings are valuable as wildlife habitats. The trees or other vegetation that make the site valuable for wildlife and enhance the environmental quality of the area all too often are cut or bulldozed, not only on the construction site itself, but from the surrounding grounds; other nearby trees may be injured seriously and die later. With planning, care, and some cost, much of this vegetation could be saved.

From the standpoint of wildlife, the species of trees saved is important, and the trees do not have to be perfect specimens. Also, the groundcover, shrubs, saplings, and smaller trees may be just as valuable to wildlife as the larger trees. They are required for some species. Such information must be brought to the attention of the designer of the project at an early stage to effect the desired conservation.

The Agricultural Research Service of the USDA points out that shade trees can add thousands of dollars to the value of residential property. It has developed criteria for determining whether trees are valuable enough to justify transplanting them and guides to methods that can be employed to protect them on building sites."[88]

Ecoplans Ltd., an environmental consulting firm in Canada, views tree preservation in urban areas as a continuous environmental planning process. Beginning with an inventory of existing vegetation, the process then encompasses design involving interactions of the planner, architect, and engineer; contract specifications or tendering; construction supervision involving input from the biologist or environmental coordinator; and rehabilitation."[89]



The flowers of the trumpet creeper vine are especially attractive to hummingbirds.

88. Agricultural Research Service, U.S. Department of Agriculture, *Protecting Shade Trees During Home Construction*, Agriculture Information Bulletin 347, 1970, 32 pp. (U.S. Government Printing Office, Washington, DC 20402.)

89. Robert S. Dorney, Comments regarding urbanization effects in letter dated September 7, 1976. (Ecoplans Ltd., 279 Weber St. N., Waterloo, Ont. N2J 3H9, Canada.)

Home sites in this subdivision were planned to make optimum use of existing topography and forest vegetation.

By reducing the frequency of mowing and taking advantage of natural succession, valuable wildlife habitat could be created on this poorly managed right-of-way.

STREETS AND HIGHWAYS

At the end of 1973, according to the U.S. Department of Transportation, there were 631,229 miles of streets and highways within municipalities.[90] This mileage provides much potential area in the form of right-of-way that can be managed as edge habitat valuable to wildlife.

The design, routing, and building of access roads, parkways, and streets in a new development can be important to both fish and wildlife. Insofar as possible, the routing should avoid the crossing of wetlands and the necessity of channelizing streams. If streets and highways are built where there will be a minimum of direct runoff of stormwaters and salty snow-melt water into receiving bodies of water, highway-created pollutants in such waters will be reduced. Areas designated as critical habitat for threatened and endangered species must be avoided in selecting highway routes, also.

By consulting with biologists in advance of road construction, planners and designers can help ensure the selection of roadside plantings that will have value for wildlife as well as for erosion control and aesthetics. In addition, the reader is referred to the wildlife plants listed in Appendix B.

In the planning and construction of new highways, consideration should be given to opportunities for fish and wildlife enhancement afforded by the creation of borrow-pit lakes. With preplanning and some simple site preparations or alterations in the morphometry of the pits, these incidentally created lakes can be made suitable for fish and wildlife. Some research into enhancing fish production in such lakes has been done.[91]

Likewise, borrow pits and earth fills that result from highway construction can be used to develop valuable wetland habitats for waterfowl, fur-bearers, and other types of wildlife and fish. Wildlife biologists can provide helpful advice on the development and management of such sites.

In developing an area both for wildlife and people, it is important to consider the various natural and cultural features of the area. This means routing roads, developing parking areas, and siting facilities in such a way as

Care was taken to preserve natural vegetation at this subdivision entrance. After the saved topsoil was replaced, the area was seeded and mulched as recommended by the U.S. Soil Conservation Service.

90. *Highway Statistics—1973*, 1973, 270 pp. Office of Highway Planning, Highway Statistics Division, Federal Highway Administration, U.S. Department of Transportation, (U.S. Government Printing Office, Washington, DC 20402.)

91. J. C. Moulton, *The Fishery Potential of Four Aquatic Environments Created by Interstate Route 91 Construction in Massachusetts*, M.S. Thesis (Amherst: University of Massachusetts, 1970), 86 pp.

to enhance man's visual reaction to wildlife and the environment.

If roads or parkways cross the migration routes of reptiles and amphibians, heavy losses will result during the breeding season. Providing tunnels or culverts underneath the road enables these animals to have safe passage. This is done in Bavaria and Switzerland. Tunnels underneath highways at deer crossings have been helpful in preventing accidents. But deerproof fences may be more effective, generally.

In the case of existing streets and highways, maintenance of vegetation through mowing and the selective use of herbicides affords opportunities to benefit wildlife. Thus, the delay of roadside mowing until mid-June or later will save many bird nests from destruction and also will benefit birds and mammals that use the cover along roads and parkways.

In the inner city, benefits to wildlife will depend in large part upon the types of trees and shrubs selected for planting (see Appendix B). The American Horticultural Society, with financial support from the U.S. Department of Transportation, has developed an informative manual on transit plantings. This manual, arranged to show 10 plant hardiness zones encompassing all of the contiguous 48 states, recommends plant species adapted for use at downtown bus stations, bus stops, and suburban terminals.[92] Again, consultation with biologists or referral to the appendices and recommended readings will help in selecting plants most useful to wildlife.

Much additional information on highway-wildlife relationships and on planning and management of highways to benefit fish and wildlife is available in a 1975 state-of-the-art report published by the U.S. Department of Transportation.[93]

AIRPORTS

Because wildlife, especially birds, at or near airports can be hazardous to human life and property, planning and management in this instance are directed toward making airports unattractive to wildlife. This means that environmental planners involved in developing the initial management strategies, as well as the resident planning staff responsible for their implementation, should, instead of providing water, food, and shelter to encourage wildlife, try to discourage wildlife by taking the opposite approach.

Between 1960 and 1972, bird strikes on aircraft in North America cost more than 100 human lives and property damage of more than $100 million. Three-quarters of civil aircraft collisions with birds occur at or near airports, usually airports located near cities. Gulls are involved in about half of all bird/aircraft impacts.

Although presently against the law in many states and municipalities, open dumps near airports formerly contributed greatly to the bird/aircraft hazard. Dumps can still be a problem if the airport is located between a dump and a water area where gulls may concentrate.[94]

Bicolor lespedeza, used here in a woodland edge planting, could also be used along a highway.

One investigator has reported that large numbers of gulls have been attracted to metropolitan areas by dumps and fish wastes from fish-handling and fish-processing plants. He states that as long as gulls are attracted to metropolitan areas, they will congregate at the relatively undisturbed parts of airports, which often are close to dumps because both are placed on marginal land, especially marshland. He found that the dumps attracting the largest number of gulls provided an open area, a large flat surface for loafing (such as a sanitary landfill), a fresh water supply, a lack of trees at the edge of the dump, and a lack of dogs. Pig farms also attract gulls, but at pig farms trees were less important and water more important.[95]

But gulls are only part of the problem. Accidents may be caused by other birds and other types of wildlife. Thus, blackbirds and starlings, when they roost at or near airports or when their flight lines cross runways and approach areas, may be ingested into turbine engines. For this reason, it is well to avoid having marshy areas nearby or dense vegetation such as pine plantations where large flocks of birds roost. Thinning a pine plantation also will reduce its attractiveness to birds.

In locating new airports, consideration should be given to the soil type, drainage conditions, type of vegetation present, and land uses in the surrounding areas. Ideally, the airport should be on land with a low capability for agriculture and wildlife. Preferably it should be on sandy land with good drainage. The land should not harbor

92. American Horticultural Society, *Transit Planting: A Manual*, undated, 156 pp. (Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, DC 20590.)

93. Daniel L. Leedy, *Highway Wildlife Relationships, Volume I, A State-of-the-Art Report*, Offices of Research and Development, Federal Highway Administration, U.S. Department of Transportation, 1975, 193 pp. (National Technical Information Service, Springfield, VA 22161.)

94. Victor E. F. Solman, *Influence of Garbage Dumps Near Airports on the Bird Hazard to Aircraft Problem*; Paper presented at the National Conference on Urban Engineering Terrain Problems, Montreal, Canada, May 7, 1973, 8 pp.

95. W. H. Drury, "Results of a Study of Herring Gull Populations and Movements in Southeastern New England," pp. 207-219 in *Colloque—Le Problems des Oiseaux sur les Aerodromes* (Paris: Institute National de la Recherche Agronomique, 1963), 326 pp.

earthworms and other ground-loving invertebrates that attract birds, nor should it be fertile enough to produce crops that provide fruit and seeds.[96]

At airports, as elsewhere, buildings attract birds. Overhanging roofs provide protection for nest construction by barn and cliff swallows and other species with similar nesting requirements. Ornaments may provide crannies and openings that can be used for bird nesting. Foundation plantings may provide berries and seeds that attract birds. Design and landscaping can eliminate all those attractions.

Flat gravel roofs, unless the drainage is carefully designed, may provide pools of rainwater that attract waders and gulls. Near some airports, flat, gravel-covered roofs of industrial buildings may hold a few inches of water and provide roosting areas for gulls. They may not be readily visible from the ground but may take off and fly into the path of aircraft approaching airport runways. In some cases, it has been necessary to ask building owners outside the airport boundary to improve the drainage on their roofs in order to minimize gull roosting.[97]

Predatory birds searching for small mammals also may cause hazards at airports. Large snowy owls, for example, perch on runway marker lights at Canadian airports. One possible means of reducing such hazards is to equip potential perches with sharp spikes on the top. Perches also should be kept at a minimum.[98]

96. Victor E. F. Solman, "Aircraft and Wildlife," pp. 137-141 in *Wildlife in an Urbanizing Environment.*

97. Victor E. F. Solman, "Airport Design and Management to Reduce Bird Problems," pp. 143-147 in *Proceedings of the World Conference on Bird Hazards to Aircraft* (Canada: National Research Council, 1969), 542 pp.

98. Solman, "Airport Design and Management."

Planners and developers may wish to keep in mind the following bird attractants at airfields, as outlined in a technical circular on wildlife control issued by Transport Canada.

1. Bird occurrence on airfields can be attributed to any one or all of the following reasons: water, food, shelter, safety, and nesting sites or because of an established migration route across the airport.

2. Existence of water impoundments of any size, from temporary after-rain puddles to ponds, water-filled drainage ditches, or local streams on the airport, will attract a wide range of bird species.

3. Food can be derived from garbage dumps at or nea the airfield; ponds that are inhabited by small fish, tad poles, frogs, insect larvae, or pond weeds; earthworms insects in general; seeds; bush and tree fruits; moles, mic lemmings, rabbits, and other animals that attract preda tory birds.

4. Shelter can be found in nooks in hangars or oth buildings and in trees and shrubs.

5. Certain birds will come to roost on runways where they will feel safe because the clear view of the surroundings eliminates the risk of a surprise attack by predators.

6. There may be a tendency for migratory birds to stop for a short time when migration routes cross an airfield.

7. Nesting sites will be found in or about buildings in dense growths of weeds, grass, legumes, trees, or shrubs.

With respect to airport management, Transport Canada recommends the following:

Water sources should be reduced or eliminated. This may be accomplished through drainage, preferably with covered tiled drains. Where open drainage ditches must remain, they should be cleaned regularly to remove silt, and vegetation should be chemically controlled so that the

water flow will not be impeded. Borrow pits, old quarries, and swampy areas should be filled. Leveling or shaping of borrow pits to ensure runoff should be included in the original construction contract.

Food sources should be reduced or, where possible, eliminated. Garbage presents one of the greatest problems. Extreme care is required in its handling and disposal. It should be placed in closed containers and buried. Municipal officials should be apprised of the problem so that dumps can be located where they present the least hazard.

Where airports are located near lakes or other large bodies of water, the dump should be on the same side of the airport as the lake to reduce the bird traffic across the airport.

Control of earthworms will require periodic sweeping of runways. This requirement will vary from site to site and season to season.

Elimination of food sources in ponds or wet areas also is necessary. Seeds of grains, peas, and so forth can be restricted by suitable land management practices. Bush and tree fruits can be eliminated by judicious thinning or removal of such material from the site. Retention of nut-bearing trees will retain the squirrel population, which is a deterrent to birds. Voles, mice, lemmings, and rabbits will be reduced by good habitat management and the removal of cover and food sources.

Transport Canada also recommends keeping infield grass areas free of weeds and at a height of between five and eight inches to make access to worms, beetles, and insects difficult to birds and to make the areas less desirable for resting or roosting. Grains and truck market crops should be removed from areas within 1,200 feet of runways and replaced with hay, alfalfa, flax, and so forth, which require little or no plowing or cultivating and attract few birds. The growing of corn, oats, and sunflowers anywhere near the airport should be prohibited.[99]

Methods of controlling birds at airports also have been summarized by the International Civil Aviation Organization.[100]

Information pertinent to planners and legislators regarding where to locate airports and how to regulate land use in adjacent areas to minimize wildlife hazards to aircraft has been developed by the Canadian Air Transportation Administration.[101]

Finally, a report prepared jointly by the National Audubon Society and the U.S. Fish and Wildlife Service provides maps showing the principal wintering areas of 143 species of North American birds that are considered to pose potential hazards to aircraft.[102] Many of these concentration areas are in coastal regions.

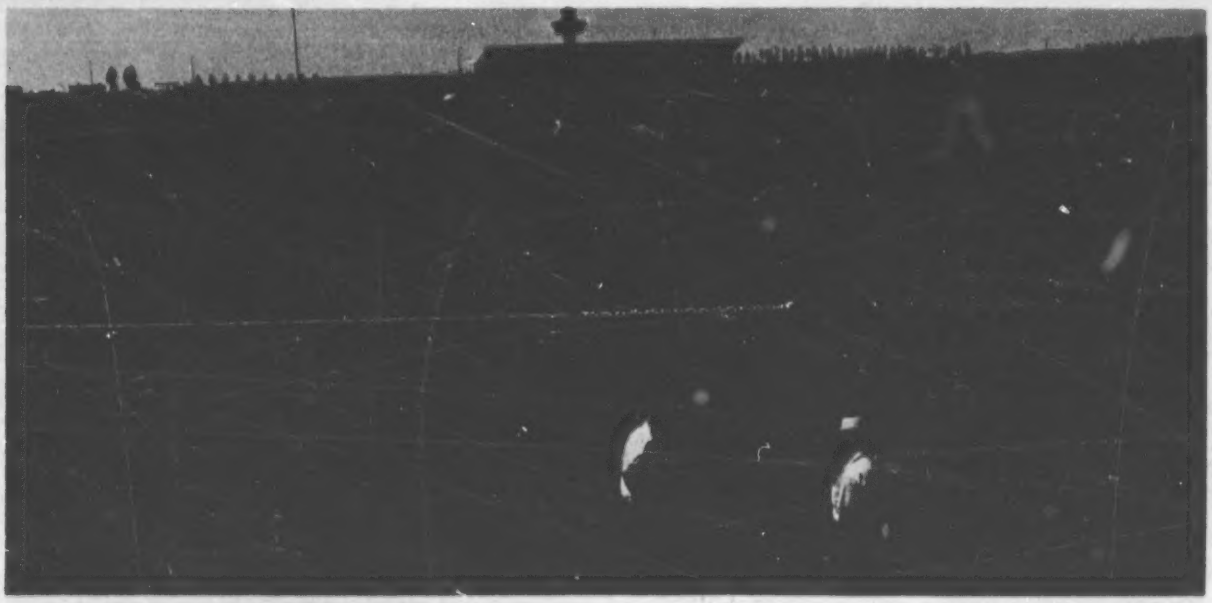
99. *Wildlife Control: Birds*, Field Maintenance Technical Circular FMTC No. 4031-1, 1971, 6 pp., appendices. (Transport Canada, 275 Slater St., Ottawa, Ont K1A ON9, Canada.)

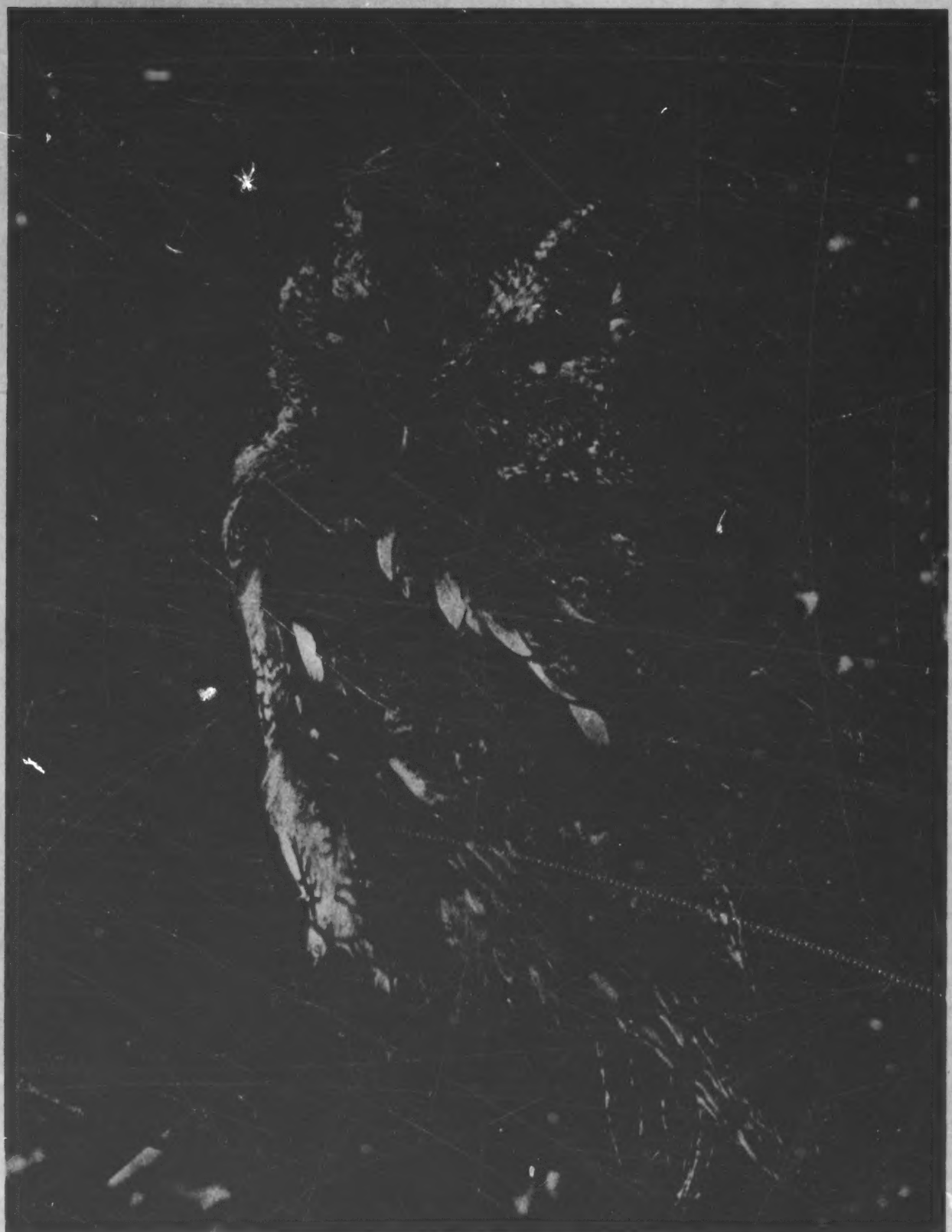
100. *Bird Control and Reduction*, Airport Services Manual, Doc. 9137-AN/898, 1975, 52 pp. (International Civil Aviation Organization, P.O. Box 400, Montreal, Que. H3A 2R2, Canada.)

101. *Land Use in the Vicinity of Airports: Planning Guidelines for the Use of Land Outside the Airport Boundary*, 1972, 46 pp., appendices. (Aviation Planning and Research Division, Civil Aeronautics Branch, Canadian Air Transportation Administration, 116 Albert St., Ottawa, Ont. K1P 5G3, Canada.)

102. Danny Bystrak et al., eds., *Wintering Areas of Bird Species Potentially Hazardous To Aircraft*, Special report prepared by the National Audubon Society and the U.S. Fish and Wildlife Service, 1974, 156 pp. (National Audubon Society, 950 Third Ave., New York, NY 10022.)

This 10-acre lake served as a desilting basin during construction of the airport and was allowed to remain. However, water bodies near airports are discouraged since they may attract birds to cross airplane flight paths.





Chapter 8. Principles for Wildlife Planning and Management: A Synopsis

Many approaches to wildlife enhancement have been suggested in this manual. These have been identified and defined primarily for the use of urban and regional planners, designers, landscape architects, and municipal officials in planning the development of new urban or suburban communities or renovating existing developments. At the same time, many of the suggested guidelines would be useful to householders involved in construction projects, gardening, yard maintenance, and planting activities on their own property.

Our emphasis has been on principles and approaches, rather than specific how-to methodologies, because of the greatly varying habitats and management measures needed to attain specific goals and objectives. By applying these principles and approaches, however, those involved in the land development process contribute importantly to improved environmental conditions for both wildlife and humans.

We shall summarize here principles applicable to both existing and planned developments and, when applicable, refer the reader to sections of the manual in which further details are provided. Some suggestions also are listed in the form of don'ts.

BASIC PRINCIPLES APPLICABLE TO BOTH URBAN AND URBANIZING AREAS

1. Planning for wildlife should be an integral part of the urban planning and development process, from the data gathering and formulation stages through the decision-making, development, and maintenance stages. The planner should think wildlife. (Pages 5, 12-14, 15-16)

2. Wildlife biologists and ecologists should be consulted at all stages of planning and development and during operation, management, and maintenance phases. Planners should seek their assistance in making wildlife inventories and in developing other relevant information on wildlife and should maintain close communication with them throughout the entire process to assure consideration of wildlife needs. (Page 14)

3. The planner should keep the public informed and encourage a holistic, ecosystem approach to environmental planning. (Page 14)

4. The retention of a suitable habitat is the primary consideration for managing or enhancing fish and wildlife. (Page 13)

5. Wildlife is as dependent upon soil fertility as are cultivated crops. Treat topsoil with the care it deserves as a valuable resource. When it has to be removed from an area, save it for later use. (Pages 13, 20-21, 34)

6. Efforts should be made to minimize soil erosion on construction sites. Get the disturbed sites revegetated quickly and establish native plant species as soon as possible to ensure permanency and low upkeep. (Pages 37, 39, 41-42)

7. In selecting plants for erosion control, use the lists in Appendix B and consult with biologists for information on plants of particular value to wildlife. (Page 42)

8. On construction sites, save all possible trees, shrubs, and ground cover. For wildlife, trees need not be perfect specimens. Dead trees may be more valuable than living trees for some species. (Pages 14, 34, 45)

9. Multilayered vegetation with a diversity of species is more stable and attracts more wildlife species than monocultures or tall tree and grass combinations. (Pages 9, 14, 17-19, 34, 35, 45)

10. Select a mixture of species native to the area or chosen with the help of wildlife biologists, horticulturists, and landscape architects when selecting trees and shrubs or other plants for landscaping or replacement purposes. They should be well suited to the local environment and valuable not only for aesthetics but for wildlife. (Pages 19, 33-35)

11. Take advantage of the opportunities afforded in water management and flood control programs. Incorporate such amenities as parkways and river walks and include wildlife wherever possible. (Pages 40-41)

12. The planner can encourage diversity by developing lakes or ponds wherever possible. (Pages 18, 24, 38-39)

13. Use natural drainage systems as much as possible. Natural channels can accommodate more storm runoff than can artificial channels. (Page 40)

14. The unnecessary channelization or alteration of stream courses and the drainage of wetland areas should be avoided. (Pages 7, 9, 37-38)

15. Pollution is a major problem. The following approaches will help to minimize its effects:

- Evaluate the effects of existing discharge standards on streams and lakes and encourage standards and housing density regulations that are adequate to prevent pollution and the overenrichment of bodies of water. (Pages 7, 8, 30-31, 37-38, 41-42)
- Encourage adoption of ordinances, housing restrictions, and zoning or other regulations to minimize pollution and overenrichment of recreational lakes that often result from septic tanks of lakeside housing developments. (Pages 30, 32, 41-42)

16. In managing metropolitan watersheds for water supply, try to avoid creating habitats, such as dense pine plantations, that are likely to be used as roosts by large numbers of blackbirds and starlings. Concentrations of such birds can result in water pollution and cause other problems. (Page 47)

17. Require progressive rehabilitation of sand and gravel mining sites as the operation proceeds. Use some of these areas for fish and wildlife and recreation purposes. (Page 39)

18. Airports should be planned and managed in such a way as to discourage wildlife and reduce the likelihood of aircraft accidents and the danger to human life and property. (Pages 47-49)

19. Ordinances should be enacted and enforced prohibiting free-roaming dogs. They are destructive of plants and wildlife. Similar ordinances to maintain better control of cats may be considered also. (Pages 13, 25-26)

20. The design and construction of buildings have great effect on bird populations:

- The house sparrow, starling, and common pigeon use for shelter, roosting, nesting, or resting the nooks, crannies, holes, and protected ledges that result from architectural design or poor construction. With proper design and good construction, these birds need not become a nuisance. Remember that the house sparrow can enter a hole about an inch in diameter and a starling can peck and tear away flimsy screening over ventilation holes. (Page 9, 26-27, 35)
- Be cautious in the use of reflective glass for buildings in naturally wooded or landscaped areas since the reflection of the trees in the glass may be a hazard to birds. (Page 27)

21. Significant numbers and diversity of wildlife species can be retained in urban and suburban areas if proper conditions are provided. (Pages 1-3)

22. The key to planning for wildlife is to meet their basic needs. (Pages 11-12)

23. Areas adjacent to the site must be considered as well as the site itself in order to maximize wildlife amenities. (Pages 19-20, 30, 35)

PRINCIPLES PARTICULARLY APPLICABLE TO URBANIZING AREAS

The steps outlined in Chapter 5 provide a valuable guide for planning in urbanizing areas. In addition to the general considerations, the following may be particularly applicable for developing areas:

1. Include wildlife considerations in the development of comprehensive plans. Such plans should include specific objectives, statements of policy, criteria, and programs for a coordinated ecosystems approach in planning and development of the community. (Pages 15-16)

2. Promote and encourage acquisition or control over areas subject to development that might better be preserved for agriculture, wildlife, or other purposes through purchase, gift, easement, zoning ordinances, subdivision regulations, purchase and lease-back, public development, assessment lien, or other procedures. (Pages 30-32)

3. Before developing new towns or planning for expansion into the countryside, determine, with the help of local scientists and naturalists or suitable agencies and organizations (see Appendix A), whether development will endanger any threatened or endangered species or unique or fragile biologic communities. Areas containing such species or communities should be identified and every effort made to preserve them. (Pages 20, 27, 30)

4. In developing new urban communities or in rehabilitating old ones, retain in as natural a condition as possible the land form, topsoil, surface drainage and groundwater systems, and original vegetation. (Pages 17, 29-30, 34, 37)

5. In planning new communities or in rehabilitating old ones, consider the practicality of cluster-type housing and the use of extra space for communal open space. (Pages 14, 15-16)

6. In planning for open space, provide for protection of streams and tributaries, wet areas, steep slopes, coastal marshes, sand dunes, shorelines, estuarine areas, and valuable biological communities. (Pages 17-18, 23-24, 37-40)

7. In coastal areas, avoid the filling in of brackish or saltwater marshes so valuable to fish and wildlife. Avoid developments that will interfere with the tidal flow of water. Also avoid the destruction of fragile dunes or other coastal and estuarine biotic communities. (Pages 39-40)

8. Avoid, where possible, constructing buildings that will be subject to flooding. Consider the use of floodplains for recreational wildlife purposes or for agriculture, which, in turn, will enhance wildlife adapted to agricultural areas. (Pages 39—40)

9. With respect to erosion and sedimentation, consider the use of detention or other on-site methods of controlling stormwater runoff. Planning for flood control should involve regional considerations of land use. (Pages 38-40)

10. Continuous, vegetated corridors connecting parklands, woods, and other vegetated areas with ponds and marshes have particular value for wild mammals and other wildlife. (Pages 22-25, 37-38)

11. In the planning and maintenance of open space areas, consider keeping less of the area mowed, mowing less frequently than usual, and permitting some of the connecting corridors to undergo natural succession. These connecting corridors of woody cover are of great value to wildlife. (Pages 35, 42-43)

12. Design roads and select their routes so as to have the least impact on fish and wildlife. This means routing

roads so there will be a minimum of direct runoff into receiving waters, avoiding unnecessary disturbance of wetland areas and drainage patterns, and leaving adequate buffer strips of vegetation between a road and a stream. (Pages 37, 41, 46–47)

13. In road construction, take advantage of opportunities afforded to maximize the fish and wildlife and recreation values of borrow pits and wetland areas created in the construction process. (Page 38)

14. In planning and developing parks, design nature trails so they have minimal impact upon the environment. The construction of elevated trails over wet areas and the posting of educational signs that explain why the collecting of plants or animals is prohibited may be helpful in the wildlife conservation effort. (Pages 26, 35)

PRINCIPLES PARTICULARLY APPLICABLE TO DEVELOPED AREAS

Many of the planning and management principles suggested above apply to developed areas also. Among the guidelines particularly recommended for planners and developers concerned with existing urban areas are the following:

1. In downtown areas, make maximum use of little-used streets, parking areas, alleyways, rooftops, backyards, sidewalks, shopping streets and markets, parks, and school grounds as open space for recreation and other purposes, including wildlife. When possible, convert vacant lots into vest-pocket parks and link them with larger parks and other open space areas. (Page 33)

2. Select tree species for their value to wildlife. They should be tolerant of city conditions such as the salt from street deicing and snow-clearance activities, air pollution, and unfavorable soil, water, and aeration conditions. Try to avoid use of single species from a single source because of the dangers of epidemic diseases, such as the Dutch elm disease. Have younger trees ready for replacement. Consider the possibility of planting trees back of the sidewalk where growing conditions are better and pollution is less severe. (Pages 33–34)

3. In planning for the development and maintenance of city parks, try to retain some natural brushy or shrubby cover in areas away from paths, while recognizing mugging and assault problems. A tall-trees and mowed-grass habitat provides less diversity of cover and is used by fewer species of wildlife than is a more diversified habitat. Leaving some dead trees standing and some fallen tree trunks or limbs on the ground to decompose also provides habitat for many kinds of wildlife. (Pages 34, 35)

4. In developing landscaping plans for university campuses and other institutional grounds, strive for a diversity of plant species and forms that provide ground cover and foliage at intermediate and tall-tree levels. (Page 44)

5. In cemetery maintenance, consider vegetation that requires less mowing and have a plan for replacing trees and shrubs as they die. As in landscaping in general, the selection of species and their arrangement can be important to wildlife. (Page 44)

6. In lieu of pesticides that may have harmful side effects on valuable fish and wildlife species, consider the use of biological control measures to combat insect pests in urban vegetation maintenance programs. (Pages 8, 34)

SOME THINGS TO AVOID

It may be just as important to know what actions or approaches not to take as it is to know how to do something. For example, knowledge of where not to build a road can be extremely important. The planner or developer will have a great amount of information if he follows the guides contained in this manual, including the wildlife and habitat inventories. However, since most of the don'ts that could be listed would be the opposite of the do's, only a few don'ts are listed:

1. Don't treat wildlife and environmental considerations as add-ons or options to be considered after plans for urban development are completed.

2. Don't expect the cooperation and support of the community automatically. Instead, set up a program of communication with citizens that continues throughout the entire process.

3. Don't make plans for new development without getting help from natural scientists and others who can identify unique biological communities, areas harboring rare and endangered species, and other areas of particular importance to wildlife and the integrity of the local ecosystem.

4. Don't perturb or disrupt the natural aspects of the area—land form, drainage patterns, topsoil, vegetation, and so forth—any more than necessary.

5. Don't use land or water for urban development—especially for the construction of buildings, roads, and other facilities—if it may have a higher, and often more long-term values for other uses.

6. Don't expect plantings for landscaping, erosion control, or other purposes to thrive unless the plant species are tolerant of or adapted to the environmental conditions on the site.

7. Don't forget that vegetation management is an important key to wildlife and environmental management and that plants selected for aesthetic and landscaping or erosion-control purposes can serve wildlife as well, if selected with the advice of wildlife biologists and ecologists.

8. Don't underrate the ability of biological systems to assimilate and dispose of man's wastes; but, also, don't forget that these systems can be overloaded or disrupted by too much nutrient or toxic material.

9. Don't forget that environmental management of airports and municipal watersheds, proper design and construction of buildings, and vegetation control can go a long way toward preventing certain unwanted birds and other wildlife on such sites.

10. Don't forget that the stability of an ecosystem is related to its diversity and requires a delicate interaction of natural processes. Therefore, affecting one component may produce an undesirable chain effect.

11. Don't forget that most people prefer to live in a residential community that affords wildlife amenities and that these added amenities increase real estate values.

12. Don't underestimate your influence on the future of wildlife in this country. Planners and developers have had

and continue to have more effect on wildlife in urban/suburban areas than wildlife managers and biologists.

13. Don't forget that proper consideration for wildlife does not require a departure from the normal planning process.

ADDITIONAL INFORMATION AND GUIDANCE

If these principles and approaches are observed, fish and wildlife and environmental quality in urban areas can be enhanced greatly. The references listed in the recommended readings also will be helpful. Planners who want more information can consult with personnel in the agencies and organizations listed in Appendix A as well as with local biologists and ecologists for details on specific wildlife requirements and management possibilities.

Although wildlife management measures that could be applied by individuals in their own backyards were largely beyond the scope of this manual, many of the principles and approaches discussed here are applicable. The support of private citizens in matters affecting the urban environment is essential. Not only do new developments affect each citizen, but the way individuals manage their property may have significant impact on communal open space and other elements of the urban scene.

Ideally, all such programs should be coordinated—with citizens, government officials, planners, developers, designers, landscape architects, engineers, wildlife biologists, and ecologists working together. It is hoped that this manual will help provide some of the needed framework for such an approach.

Appendix A. Sources of Information and Assistance

NAMES AND ADDRESSES OF KEY PEOPLE AND ORGANIZATIONS IN THE CONSERVATION FIELD

There is a constant turnover in professional societies, conservation organizations, commissions, state and federal agencies, and other groups concerned with the planning and management of the nation's natural resources. Agencies are reorganized frequently, and new ones are formed. New programs affording possible financial assistance are developed, and other, older programs are revised. Thus, it becomes difficult for planners, developers, and others to know how to contact individuals, agencies, or organizations when advice or assistance is needed.

The *Conservation Directory*, published by the National Wildlife Federation, fills this need surprisingly well in that it is an annual compilation of the organizations and officials, both public and private, concerned with a broad array of conservation programs. For example, the reader will find for each state the names and addresses of the Cooperative Extension Service agents, the U.S. Soil Conservation Service state conservationists and field biologists, the state geologists and geological surveys, and the directors of the state conservation or fish and wildlife departments. Also listed are the U.S. federal departments, agencies, and offices, including not only the Washington, D.C., headquarters addresses and key officials, but, in many cases, those of the regional or state offices that can be most helpful in advising on local matters. The directory also includes most of the private conservation organizations and professional societies along with a brief description of their goals and objectives and the publications issued by each.

Rather than duplicate this information here, we would suggest that the reader obtain or refer to a copy of the *Conservation Directory*. This publication can be obtained from its producer and publisher, the National Wildlife Federation, 1412 Sixteenth St., N.W., Washington, DC 20036, for $3 per copy.

Planners and developers may wish to obtain, in addition, the latest *U.S. Government Manual* from the U.S. Government Printing Office, Washington, DC 20402. This manual provides information on the functions and services rendered by the various federal departments, agencies, and offices and gives complete addresses, including zip codes.

In the following sections, some suggestions are given on agencies or organizations that might be able to provide information of interest to planners and developers. This information is presented in abbreviated form and is not to be considered an exhaustive listing of sources of assistance.

FISH AND WILDLIFE: LIFE HISTORY AND MANAGEMENT INFORMATION

Depending on their specific interests, planners and developers can obtain good information on any of hundreds of species of fish and wildlife either through research or by contacting an appropriate professional society—for example, the Wildlife Society, the American Fisheries Society, the American Society of Mammalogists, the American Ornithologists' Union or other ornithological societies, the Ecological Society of America, or numerous other societies—or by contacting the U.S. Fish and Wildlife Service, Washington, DC 20240.

The U.S. Fish and Wildlife Service publishes *Wildlife Review*, which is an abstracting service for wildlife management and lists hundreds of publications dealing with birds and mammals, their habitat and management. Similarly, the Service publishes *Sport Fisheries Abstracts*, which includes abstracts of the current literature in sport fishery research and management. These abstracting journals will be found in most large libraries. Further information about them can be obtained from the U.S. Fish and Wildlife Service, Editorial Office, Colorado State University, Aylesworth Hall, Fort Collins, CO 80629.

Another valuable source of information on fish and wildlife and related resources is available in the annual *Transactions of the North American Wildlife and Natural Resources Conference*. Several of these conferences in recent years have included sessions dealing with urban wildlife planning and management. These transactions will be found in a great many libraries at universities and elsewhere. Also, they can be purchased from the conference sponsor, the Wildlife Management Institute, 1000 Vermont Ave., N.W., Washington, DC 20005. Both the institute and the National Wildlife Federation issue bulletins or reports that will help planners keep abreast of legislation and other developments affecting fish and wildlife resources.

As the agency charged with implementation of the Endangered Species Act of 1973, the U.S. Fish and Wildlife Service can provide information on research and protection programs related to such plant and animal species. As suggested previously, however, planners, developers, and builders also should contact local naturalists for help in identifying any species that might possibly be endangered through their developments.

The U.S. Fish and Wildlife Service, Washington, DC 20240; the U.S. Soil Conservation Service, Washington, DC 20250; and the state conservation departments can provide valuable information on the construction and management of fish ponds. If planners and developers are involved in road construction and the installation of culverts that might block the passage of anadromous fish, they can get good advice from the U.S. Forest Service, Washington, DC 20250, regarding the size and design of culverts that will permit fish passage under different conditions of stream volume and velocity. Information on fishery stocks is available from the U.S. Fish and Wildlife Service, U.S. Soil Conservation Service, and the state fish

and wildlife departments. Not to be overlooked are the commercial hatcheries.

FISH AND WILDLIFE: CONTROL

With respect to wildlife control, the regional offices of the U.S. Fish and Wildlife Service may be able to give assistance. State agricultural extension service offices also have bulletins and leaflets, many of them prepared in cooperation with the U.S. Fish and Wildlife Service, concerning common problems of animal control. Additional information may be available from university wildlife management departments.

Similarly, the U.S. Fish and Wildlife Service has done extensive research on the control of rough fish and noxious aquatic weeds, and the research results have been published. Information on fish control can be obtained from the Director, Fish Control Laboratories, U.S. Fish and Wildlife Service, P.O. Box 862, LaCrosse, WI 54601.

VEGETATION MANAGEMENT

The U.S. Department of Agriculture, through its Forest Service, Soil Conservation Service, and Agricultural Research Service—all of which can be contacted through offices in Washington, DC 20250—has a wealth of information on vegetation management, including vegetation of urban areas and as related to wildlife. Planners and developers can get helpful information from the Soil Conservation Service on vegetation as a means of controlling soil erosion and also on the experience of soil conservation programs involving plantings for both erosion control and wildlife.

At the local level the county agricultural agents can provide much useful information on plants, plant requirements, and plant diseases. The National Arboretum; private and municipal arboretums; the American Horticultural Society, Mt. Vernon, VA 22121; and state forestry and natural resources departments also are valuable sources of information on plant materials. The U.S. Fish and Wildlife Service has much information on the management of marsh vegetation for wildlife.

SOILS AND GEOLOGY

Soil testing can be done through the U.S. Agricultural Extention Service office of each state and by the state university laboratories. Much assistance on interpreting soil maps can be provided by the U.S. Soil Conservation Service.

The U.S. Geological Survey, National Center, Reston, VA 22092, can assist in identifying sand and gravel deposits and in providing much other information of interest to planners and developers, including many different kinds of maps useful in planning.

Both the Bureau of Mines and the Bureau of Outdoor Recreation of the U.S. Department of the Interior, Washington, DC 20240, can provide information on the reclamation of strip-mined areas for recreation and other purposes. The National Sand and Gravel Association, 900 Spring St., Silver Spring, MD 20910, also has information on progressive rehabilitation of areas from which sand and gravel have been extracted. Some of these areas are valuable for fish and wildlife.

WATER AND FLOOD CONTROL INFORMATION

A great many federal agencies are concerned with water resources, including several within the U.S. Department of Agriculture and the Department of the Interior, the U.S. Environmental Protection Agency, TVA, the Army Corps of Engineers, and the U.S. Water Resources Council. Details on the federally subsidized National Flood Insurance Program are available from the Federal Insurance Administration, U.S. Department of Housing and Urban Development, Washington, DC 20410.

The U.S. Environmental Protection Agency, 401 M St., S.W., Washington DC 20460, sets and enforces environmental standards; conducts research on the causes, effects, and control of environmental problems; and assists states and local governments in these matters. The report *Water Quality Criteria 1972*, prepared for EPA by a committee of the National Academy of Sciences/National Academy of Engineering, is available from the U.S. Government Printing Office, Washington, DC 20402, at $12.80 (Stock No. 5501-00520). It contains much valuable information on water pollutants and their effects on aquatic organisms and on the tolerance of many organisms to pollutants.

The state government manuals of the various states are valuable sources of information on the state water resource agencies. Another source of information on state agencies and their areas of responsibility is the *Book of the States*, published by the Council of State Governments, Iron Works Pike, Lexington, KY 40505.

FEDERAL FINANCIAL ASSISTANCE PROGRAMS

Among the many federal financial assistance programs in which planners and developers might be interested are the small watershed projects (P.L. 83-566) administered by the U.S. Soil Conservation Service; Coastal Zone Management and Sea Grant Programs of the U.S. Department of Commerce; the Open Space Parks, Natural Resources, Historic and Scenic Program (P.L. 87-70), administered by the U.S. Department of Housing and Urban Development; the Urban Planning Assistance (701) Program (P.L. 83-560), also administered by the U.S. Department of Housing and Urban Development; and the Land and Water Conservation Fund, administered by the Bureau of Outdoor Recreation, U.S. Department of the Interior.

Thus, under P.L. 83-566, 50 per cent grants (and loans) are provided to state and local agencies for construction, purchase of easements, and minimum basic facilities needed for access to and enjoyment of public recreation areas. The Coastal Zone Management and Sea Grant Programs administered by the National Oceanic and Atmospheric Administration, Washington, DC 20230, provide funding for programs related to land use, preservation, and recreation in urban areas of state coastal zones.

The U.S. Department of Housing and Urban Development, 451 Seventh St., S.W., Washington, DC 20410, through P.L. 87-70 provides 50 per cent matching grants for acquiring, developing, and preserving open space for recreation, public parks, conservation of natural resources, and so forth. Through Title IV, Section 401, of that act HUD provides 50 per cent grants to assist in improvement of open space in urban areas. Through the 701

Program, HUD provides grants for two-thirds of the total cost of comprehensive urban development planning programs in small communities and metropolitan areas, including preparation of comprehensive plans and development of capital improvement programs.

Within the U.S. Department of the Interior, the Bureau of Outdoor Recreation, through the Land and Water Conservation Fund, grants funds to states and, through them, to political subdivisions and other units of state government for planning, acquisition, and development of public outdoor recreation areas and facilities.

The Bureau of Reclamation, U.S. Department of the Interior, in administering the Federal Water Project Recreation Act, P.L. 89-72, provides guidelines for analysis and development of the recreation and fish and wildlife enhancement potentials of water resources projects. This law provides for federal participation, on a cost-sharing basis, in the development of recreation and fish and wildlife enhancement facilities up to a maximum of $100,000 for each reservoir.

STATE AND PRIVATE FINANCIAL ASSISTANCE PROGRAMS

Planners and developers should be alert to state programs that provide funds for urban and regional planning and development projects that could be used to enhance fish and wildlife in urban/suburban areas. Some of the approaches taken by states, including the issuance of bonds for acquisition and development, have been discussed in chapter 5 of this manual.

Other possible sources for the funding of sound programs to enhance fish and wildlife and the quality of the environment in urban/suburban areas include: foundations such as Rockefeller and Ford; and preservation groups such as the Nature Conservancy, Suite 800, 1800 N. Kent St., Arlington, VA 22209, and the Izaak Walton League of America Endowment, Inc., P.O. Box 535, La Grange, IL 60525; environmental action groups, which vary from state to state and include some national organizations, such as the National Audubon Society, 950 Third Ave., New York, NY 10022; and private industry.

Appendix B. Regional Listings of Selected Plants Ranked According to Their Value for Wildlife

The information used in developing this appendix was taken from the book *American Wildlife and Plants* by Martin, Zim, and Nelson. Martin and Nelson are recognized nationally as experts on the food habits of wild birds and mammals, and Zim was serving as educational consultant to the U.S. Fish and Wildlife Service at the time the book was prepared. (See listing on page 62.)

Analysis of the contents of the crops and/or stomachs of more than 300 species of birds and mammals collected from various regions of the United States made it possible to determine approximately the extent to which about 250 different genera of plants have been used by wildlife. Although the authors ranked usage as food of the plant groups by each of seven wildlife categories—water birds, marsh and shore birds, upland game birds, songbirds, fur and game mammals, small mammals, and browsers—we have used combined ratings in developing this simplified chart. However, it should be recognized that the value of different plant species may change under certain circumstances.

For example, during periods when certain plants are covered with deep snow or ice, animals may consume other plants, not because they are preferred, but because they are available. Also, it is recognized that some plants may be very important to certain wild animals because of their value as cover rather than as food. Many genera of plants provide both food and cover.

Many studies of the food habitats of certain wildlife species have been made in local areas since this book was published, but no other study provides comparably broad coverage. The food-use information presented can aid in planning wildlife habitat developments in residential and other types of areas. More detailed information is available in the book and in other publications cited in this manual.

TABLE 1. NORTHEAST REGION

Woody Plants	Upland Weeds and Herbs	Marsh and Aquatic Plants	Cultivated Plants
Oak	Ragweed	Smartweed	Corn
Blackberry	Bristle grass	Pondweed	Wheat
Wild cherry	Sedge	Wild rice	Oats
Pine	Crabgrass	Bulrush	Apple
Dogwood	Panic grass	Wild celery	Cultivated cherry
Grape	Pigweed	Naiad	Timothy
Maple	Clover	Cord grass	Barley
Beech	Sheep sorrel	Widgeon grass	
Blueberry	Goosefoot	Cut-grass	
Birch	Dropseed grass	Spike rush	
Sumac	Bluegrass	Eelgrass	
Aspen	Pokeweed	Bur reed	
Spruce	Dandelion	Wild millet	
Hickory	Plantain	Duckweed	
Fir		Algae	
Alder		Arrowhead	
Poison ivy		Muskgrass	
Black gum		Arrow arum	
Mulberry			
Elm			
Cedar			
Serviceberry			
Hazelnut			
Willow			
Hemlock			
Greenbrier			
Ash			
Elderberry			
Virginia creeper			
Tulip tree			
Mountain ash			
Holly			
Hawthorn			
Black walnut			

TABLE 2. SOUTHEAST REGION

Woody Plants	Upland Weeds and Herbs	Marsh and Aquatic Plants	Cultivated Plants
Oak	Panic grass	Bulrush	Corn
Pine	Bristle grass	Pondweed	Rice
Blackberry	Ragweed	Widgeon grass	Wheat
Wild cherry	Paspalum	Cord grass	Oats
Greenbrier	Crabgrass	Smartweed	Apple
Grape	Dovewood	Spike rush	
Blueberry	Sedge	Duckweed	
Hickory	Pokeweed	Naiad	
Black gum	Lespedeza	Water lily	
Holly		Muskgrass	
Poison ivy		Chufa	
Beech		Arrowhead	
Maple		Algae	
Virginia creeper		Cattail	
Persimmon		Wild millet	
Wax myrtle		Coontail	
Dogwood		Wild rice	
Mulberry		Salt grass	
Tulip tree		Wild celery	
Ash			
Palmetto			
Sweet gum			
Elderberry			
Cedar			
Hackberry			
Swamp ironwood			

TABLE 3. PRAIRIE REGION

Woody Plants	Upland Weeds and Herbs	Marsh and Aquatic Plants	Cultivated Plants
Oak	Bristle grass	Pondweed	Corn
Hackberry	Ragweed	Bulrush	Wheat
Prickly pear	Sunflower	Widgeon grass	Oats
Wild rose	Panic grass	Muskgrass	Sorghum
Wild cherry	Knotweed	Smartweed	Apple
Cedar	Pigweed	Wild millet	Alfalfa
Grape	Doveweed	Spike rush	Barley
Sagebrush	Goosefoot	Algae	
Snowberry	Russian thistle	Bur reed	
Sumac	Crabgrass	Horsetail	
Poison ivy	Dropseed grass	Horned pondweed	
Persimmon	Clover	Water milfoil	
Mulberry	Needle grass	Bur reed	
Dogwood	Sedge	Cattail	
Serviceberry	Fescue grass		
Saltbush	Grama grass		
Holly			
Blackberry			
Pine			
Mesquite			
Alder			
Barberry			
Bearberry			
Virginia creeper			
Rabbit brush			

TABLE 4. MOUNTAIN-DESERT REGION

Woody Plants	Upland Weeds and Herbs	Marsh and Aquatic Plants	Cultivated Plants
Pine	Bristle grass	Pondweed	Wheat
Sagebrush	Pigweed	Bulrush	Oats
Mesquite	Sunflower	Widgeon grass	Corn
Prickly pear	Ragweed	Muskgrass	Sorghum
Oak	Sedge	Smartweed	Barley
Cedar	Knotweed	Salt grass	Alfalfa
Manzanita	Grama grass	Spike rush	Cultivated cherry
Douglas fir	Russian thistle	Wild millet	Apple
Wild cherry	Dandelion	Horned pondweed	
Serviceberry	Filaree	Algae	
Gooseberry	Goosefoot	Water milfoil	
Aspen	Wheat grass	Bur reed	
Hackberry	Fescue grass		
Saltbush	Snakeweed		
Fir	Bromegrass		
Willow	Deer vetch		
Birch	Locoweed		
Blackberry	Eriogonum		
Rabbit brush	Purslane		
Maple	Bluegrass		
Spruce	Needle grass		
Bitterbush	Doveweed		
Alder	Tarweed		
Creosote	Clover		
Elaeagnus	Plantain		
Blueberry	Spiderling		
Buffalo berry	Fiddleneck		
Grape	Crownbeard		
Barberry	Hilaria		

TABLE 5. PACIFIC REGION

Woody Plants	Upland Weeds and Herbs	Marsh and Aquatic Plants	Cultivated Plants
Pine	Wild Oats	Pondweed	Wheat
Oak	Filaree	Bulrush	Barley
Elderberry	Pigweed	Widgeon grass	Corn
Poison oak	Bristle grass	Muskgrass	Cultivated cherry
Blackberry	Turkey mullein	Smartweed	Grape
Manzanita	Knotweed	Wild millet	Sorghum
Buckthorn	Tarweed	Spike rush	California pepper tree
Wild cherry	Redmaids	Eelgrass	Fig
Prickly pear	Bromegrass	Algae	Rice
Ceanothus	Star thistle	Horned pondweed	Apple
Cedar	Sedge	Salt grass	Alfalfa
Douglas fir	Deer vetch	Water milfoil	
Fir	Chickweed	Bur reed	
Dogwood	Miners lettuce	Horsetail	
Mesquite	Ragweed		
Serviceberry	Nightshade		
Spruce	Fescue grass		
Willow	Clover		
Gooseberry	Sunflower		
Snowberry	Lupine		
Bitterbush	Eriogonum		
Alder	Goosefoot		
Birch	Bur clover		
Sagebrush	Russian thistle		
Mistletoe	Bluegrass		
Blueberry	Fiddleneck		
Aspen			
Mountain mahogany			
Salal			
Madrone			
Buffalo berry			

Appendix C. Recommended Readings

Allen, Durward L. *Our Wildlife Legacy.* Funk and Wagnalls Co., 10 E. 53rd St., New York, NY 10022. 1974. 422 pp. $4.95 (paperback).

A classic dealing with fish and wildlife as related to man; what man has done that affects wildlife, unintentionally or deliberately; and the status of wildlife conservation and management. The book has been used widely as a text in wildlife management, and it is sound, biologically and philosophically. The author discusses successes and failures in wildlife management. The book contains voluminous reference notes and a valuable bibliography.

Briggs, Shirley A., ed. *Landscaping for Birds.* Audubon Naturalist Society of the Central Atlantic States, Inc., 8940 Jones Mill Road, Chevy Chase, MD 20015. 1973. 72 pp.

There are seven chapters in this illustrated booklet dealing with various aspects of planting and landscaping for birds. Included are suggested plans for bird gardens of various sizes, with sketches showing the location of plants in relation to a house and lot boundaries. Species of plants especially attractive to birds are illustrated. Suggestions on planting methods are included, along with descriptions of the plants and their site requirements.

Burger, George V. *Practical Wildlife Management.* Winchester Press, 205 E. 42nd St., New York, NY 10017. 1973; reprinted in 1975. 218 pp. $10.

This book is an excellent primer on the practical aspects of wildlife management. Written for the layman, it describes the relationships of plants and animals to other components of the environment; discusses the requirements of wildlife; and explains in simple terms what can be done to manage for wildlife—specifically small game, forest game, waterfowl, and songbirds. Emphasis is on habitat management, but other approaches, such as artificial feeding, stocking, erection of nest boxes, and the "human element" are discussed. Throughout the text and in a special appendix, public and private sources of information and assistance are listed.

Darling, F. Fraser, and Milton, John P., eds. *Future Environments of North America: Transformation of a Continent.* Natural History Press. Doubleday & Co., Inc., 501 Franklin Ave., Garden City, NY 11530. 1966. 767 pp. $12.95; $5.95 (paperback).

This book constitutes the record of a conference convened by the Conservation Foundation to ponder the influence of man upon his own environment. Inasmuch as one of the dominant trends has been toward urbanization, several of the papers presented by scientists and authorities deal with the urbanization process and its effect upon the environment. Various papers are concerned with preservation of endangered species and their habitats, economics vs. ecology, regional planning and development, and organization and implementation of environmental programs.

Dorney, Robert S., and Rich, S. C. "Urban Design in the Context of Achieving Environmental Quality Through Ecosystems Analysis." *Contact,* Vol. 8 (1976), pp. 28-48. (Contact Robert S. Dorney, Ecoplans Ltd., 279 Weber St. N., Waterloo, Ont. N2J 3H9, Canada.)

This paper traces four levels of urban design found in American cities. The authors indicate that there has been substantial improvement in the past two decades in the inclusion of ecological considerations. Ecosystem planning is described as a multidisciplinary systems approach that considers cultural, historical, abiotic, and biotic features.

Gellner, Sherry; Russell, Christine; and Edinger, Philip. *Attracting Birds to Your Garden.* Sunset Books, Lane Publishing Co., Menlo Park, CA 94025. 1975. 96 pp. $2.45 (paperback).

This informative publication, by the editors of Sunset Books and *Sunset Magazine,* discusses 33 popular garden birds, their habits, where they are found, and how to attract them; supplemental feeding; bird houses; and plants birds like the most. The latter section, comprising 47 pages, would be of particular interest to planners, landscape architects, and builders, since information is provided both on plants and their growth habits and on the birds attracted by them.

Gill, Don, and Bonnett, Penelope. *Nature in the Urban Landscape: A Study of City Ecosystems.* York Press, 101 E. 32nd St., Baltimore, MD 21218. 1973. 209 pp. $12.

A well-written book dealing with urban ecosystems in the United States, England, and Canada. Characteristics of urban flora and fauna are discussed, with particular attention to London and Los Angeles. Much of the treatment of wildlife in Los Angeles is concerned with coyotes. Separate chapters deal with planning for

wildlife and with management and wildlife habitat. The authors conclude that natural communities can be maintained in urban areas but suggest many topics in need of research.

Hanson, William A., and Bigelow, Frans. *Lake Management Case Study: Westlake Village, California.* Technical Bulletin No. 73. Urban Land Institute, 1200 18th St., N.W., Washington, DC 20036. 1977. 113 pp.

The authors discuss the problems of effective management of a man-made body of water.

Keyes, Dale L. *Land Development and the Natural Environment: Estimating Impacts.* Urban Institute, 2100 M St., N.W., Washington, DC 20036. 1976. 128 pp. $4.95.

One of a series of reports by the Urban Institute's Land Use Center dealing with evaluation of land developments and their economic, environmental, and social impacts. This report treats impacts relating to the natural environment, such as air quality, water quantity and quality, wildlife and vegetation, and noise. Information on effects of development on vegetation and wildlife is somewhat limited in scope but should be helpful to planners and developers.

Kirkpatrick, R. B., and Davey, Stuart P. "Downtown Wildlife." *National Wildlife,* Vol. 5 (August-September 1967), pp. 4-9. (Published by National Wildlife Federation, 1412 Sixteenth St., N.W., Washington, DC 20036.)

There are birds and other types of wildlife in the city if we take time to notice them. If we want more, it will be necessary to make our interest known, pay for the wildlife, and manage it with care.

Martin, A. C.; Zim, H. S.; and Nelson, A. L. *American Wildlife and Plants: A Guide to Wildlife Food Habits.* Dover Publications, Inc., 180 Varick St., New York, NY 10014. 1951. 500 pp. $4.50 (paperback).

This book, originally published by McGraw-Hill Book Co., is a guide to the food habits of wildlife and the trees, shrubs, weeds, and herbs they use. The final chapter provides a national list of plant groups ranked according to their use by wildlife as food and regional lists of wildlife plants indicating the extent to which particular kinds of plants have been used by seven types of wildlife: water birds, marsh and shore birds, upland game birds, songbirds, fur and game mammals, small mammals, and browsers. Range maps of many of the wildlife species are shown. The simplified plant ranking lists in Appendix B were drawn from this book.

McKeating, Gerald B. *Nature and Urban Man: Proceedings of a Symposium.* Special Publication No. 4. Canadian Nature Federation, 46 Elgin St., Ottawa, Ont. K1P 5K6, Canada. 1975. 134 pp.

A compilation of interesting papers that treat urban wildlife resources, effects of urbanization on wildlife habitat, wildlife responses to changed conditions, and planning for nature and urban man. Seven of 18 papers presented at the conference focus on planning.

Noyes, John H., and Progulske, Donald R., eds. *Wildlife in an Urbanizing Environment.* Planning and Resource Development Series No. 28. University of Massachusetts, Amherst, MA 01002. 1974. 182 pp. $3.

Proceedings of a symposium held November 27-29, 1973, at which 33 papers were presented on urban wildlife subjects ranging from philosophy to public and private roles in urban wildlife management, results of urban wildlife studies, and urban wildlife-people relationships. Research projects reported upon deal with songbirds, waterfowl, coyotes, squirrels, raccoons, wildlife damage, reptiles and amphibians, and diseases and parasites. One paper relates specifically to incorporating wildlife into new-town planning; another treats urban wildlife as a tool in education.

Shomon, J. J.; Ashbaugh, B. L.; and Tolman, Con D. *Wildlife Habitat Improvement.* National Audubon Society, 950 Third Ave., New York, NY 10022. 1966. 96 pp. $2.50.

This is a well-illustrated publication that describes how to improve habitat for wildlife in nature centers, parks and natural areas, school and college lands, camp and recreation properties, refuges and sanctuaries, arboretums and forest preserves, rural life centers, botanical gardens, homesites, and special areas.

Stearns, Forest, and Montag, Tom. *The Urban Ecosystem: A Holistic Approach.* Community Development Series, Vol. 14. Prepared by the Institute of Ecology for the National Science Foundation's Research Applied to National Needs (RANN) program. Dowden, Hutchinson & Ross, Inc. 1974. 203 pp. $18; ASPO members and PAS subscribers, $17. Available from ASPO.

The authors discuss urban areas as ecosystems in which wild animals and plants are components along with man. They suggest that, in the management of urban parks and green areas, plant communities more nearly self-sustaining than the present manicured areas of regularly mowed grass be used. Concentrations of wastes generated by urban populations swamp the processing capacities of adjacent systems causing them to function inefficiently or not at all.

Tanner, Ogden. *Urban Wilds.* The American Wilderness Series. Time-Life Books, Rockefeller Center, New York, NY 10020. 1975. $8.95.

This well-illustrated book identifies and discusses the many "natural" areas available within and adjacent to urbanization. Tanner and the editors of Time-Life Books clearly demonstrate that people in urban areas have the opportunity to experience the amenities of nature in their own back yards.

Terres, John K. *Songbirds in Your Garden.* Hawthorn Books, Inc., 260 Madison Ave., New York, NY 10016. 1977 (rev. ed). 274 pp. $4.95 (paperback).

This book is written primarily for people who have a back yard or garden and are interested in attracting birds. It discusses feeding, watering, and building nest boxes, the care and feeding of young birds, how to attract hummingbirds, and how to solve some of the problems involved in feeding birds or caring for nest boxes. Of particular value is the chapter on ornamental plantings for birds and an appendix that lists, by regions, the trees, shrubs, and vines especially attractive to birds.

Thurow, Charles; Toner, William; and Erley, Duncan. *Performance Controls for Sensitive Lands: A Practical Guide for Local Administrators.* Planning Advisory Service Report No. 307/308. American Society of Planning Officials, 1313 E. 60th St., Chicago, IL 60637. 1975. 156 pp. $12; $10 to PAS subscribers.

Part I deals with the importance of such environmentally sensitive areas as streams and creeks, aquifers, wetlands, woodlands, and hillsides, and Part II with environmental performance standards. Examples of erosion and runoff ordinances in several counties are included, as well as excerpts of other types of ordinances in cities and counties throughout the U.S. Sources of technical assistance are listed in addition to recommended readings.

U.S. Department of the Interior. *Man and Nature in the City.* Proceedings of a symposium sponsored by the Bureau of Sport Fisheries and Wildlife to explore the role of nature in the urban environment. U.S. Government Printing Office, Washington, DC 20402. 1969. 92 pp. $1.

Among the papers in the proceedings is "Meeting Urban Wildlife Needs" by Ralph A. MacMullan, who recognizes that wildlife is important to urban dwellers but says that, if any is to be retained, an educated and informed electorate is needed. He suggests the place to begin is in the schools. Other provocative papers deal with urban planning (Philip H. Lewis, Jr.); human needs for the natural environment (Edward Stainbrook); and urban youth and natural environments (Rose Blaustein).

U.S. Environmental Protection Agency. *Carrying Capacity in Regional Environmental Management.* A. B. Bishop et al. Socioeconomic Studies Series, EPA 600/5-74-021. U.S. Environmental Protection Agency, Washington, DC 20460. 1974.

This report examines the concept of carrying capacity in the context of regional environmental management. The authors conclude that the concept, in this light, must be broadened to include the complex relations among resources, infrastructure and production activities, residuals, and societal preferences for quality of life within both the natural and human environments.

U.S. Fish and Wildlife Service. *A Handbook for Habitat Evaluation Procedures.* B. S. Flood et al. Fish and Wildlife Service Resource Publication 132. U.S. Fish and Wildlife Service, Washington, DC 20240. 1977. 77 pp.

This handbook presents criteria and a rating system that were developed to measure the capability of an area in Crawford County, Missouri, to support an animal species or group of species. The system can serve as a prototype for preparing other habitat-evaluation handbooks. The principles and ideas contained in the book provide a sound basis for developing other sets of criteria, and only slight modifications would be needed to adapt the criteria to closely related ecosystems.

——. *National Survey of Fishing and Hunting 1975.* U.S. Government Printing Office, Washington, DC 20402. 1975. 108 pp.

In addition to providing data on fishing and hunting and the people participating in these sports, this publication provides information on the numbers of people participating in other selected outdoor recreation activities, including nature walks and wildlife and bird photography.

U.S. Forest Service. *Community and Urban Forestry: A Selected and Annotated Bibliography.* John W. Andresen. U.S. Forest Service Area Office, State and Private Forestry—Southeastern Area, 1720 Peachtree Road, N.W., Atlanta, GA 30309. 1974. 195 pp.

This bibliography contains 2,250 annotated references to literature on urban forestry. Citations are grouped by regions and according to 10 subject areas for each

region, ranging from planning and legislation to education. Publications listed under the heading Ecological and Animal Influences, Beautification, and Watershed Manangement total 199.

U.S. Geological Survey. "Earth Science and the Urban Environment." Donald R. Nichols. Pp. 23-29 in *U.S. Geological Survey Annual Report, Fiscal Year 1975.* U.S. Government Printing Office, Washington, DC 20402. 1975.

An interesting account of construction materials, minerals, fuel, water, and so forth as the bases for urbanization; natural hazards such as earthquakes, landslides, volcanic eruptions, flooding, and subsidence as factors to be considered in urbanization; and opportunities and constraints in land-use management afforded by earth sciences. Some of the information and services, including mapping, that can be provided by the U.S. Geological Survey and other agencies are described.

-------. *A Procedure for Evaluating Environmental Impact.* Luna B. Leopold et al. Geological Survey Circular 645. U.S. Geological Survey, Reston, VA 22092. 1971. 13 pp.

An information matrix system much used as a guide for environmental impact reporting and as a systematic reference.

U.S. National Park Service. *Urban Ecology Series.* Theodore W. Sudia. U.S. Government Printing Office, Washington, DC 20402. Series, published between 1971 and 1976.

A series of seven bulletins in the *Urban Ecology Series*, with the titles "Man, Nature, City," "The Vegetation of the City," "Ecology of the Walking City," "The River in the City," "The City as a Biological Community," "The City as a Park," and "Technology Assessment in the City."

Untermann, Richard, and Small, Robert. *Site Planning for Cluster Housing.* Van Nostrand Reinhold Co., 430 W. 33rd St., New York, NY 10001. 1977. 306 pp. $22.50.

This book places emphasis upon the development of low-use, medium-density cluster environments that optimize the interrelationship of land form and house form. The authors have recognized that there is a growing public awareness of the need to conserve the land, its natural systems, its open space, and its capability to yield sufficient material and energy sources. This book applies current theory and information on cluster housing, human needs in housing, and site planning to an action-oriented format intended to aid professionals in designing and implementing housing developments at any scale.

Wildlife Management Institute, 1000 Vermont Ave., N.W., Washington, DC 20005. *Current Investments, Projected Needs, and Potential New Sources of Income for Nongame Fish and Wildlife Programs in the United States.* 1975. 112 pp. $1.

A report prepared by the Institute in cooperation with the Public Affairs Information Service, University of Missouri-Columbia, under contract to the U.S. Council on Environmental Quality and the U.S. Fish and Wildlife Service.

-------. "The Influence of Parkland Habitat Management on Birds in Delaware." Richard M. Burr and Robert E. Jones. Pp. 299-306 in *Transactions: Thirty-third North American Wildlife and Natural Resources Conference.* 1968. Out of print; library copy may be available.

The authors discuss effects of urbanization on birds and compare bird populations on unmanaged woodlots with those on woodlots managed for parkland and heavily used by man. Parkland management coupled with heavy human use apparently causes a decrease in the breeding bird species. When possible, brush should be left to encourage birds.

-------. "Input of Wildlifers Expected by Urban and Regional Planners: Views of the American I stitute of Planners." Royce LaNier. In *Transactions, Forty-first North American Wildlife and Natural Resources Conference.* 1976. $8.50.

Wildlifers need to provide information that will help define a vital function for wildlife and natural areas as indicators of health within an urban ecosystem. Until such information is available, no major reordering of urban development priorities is likely.

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As the Nation's principal conservation agency, the U.S. Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. Administration.